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– Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field;

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MEETING THEME

Increasing importance is being given to the exploitation of scientific and technical information developed as a result of defence and aerospace research. It is therefore desirable to review the state-of-the-art in 1978 and to ensure that the results of this study are communicated to industry, and in particular to those who could benefit from the utilization of information resulting from aerospace research and development. Further, the information services play an essential part in technology transfer; the meeting will therefore survey the main facilities in the field of information now available to industry, of which in many cases they are unaware, such as the major data banks (Chemical Abstracts, INSPEC, NASA/RECON, etc.), Information Analysis Centres, and interfaces between Information Centres and manufacturers (Industrial Liaison Officers), and compare the various methods of Information Transfer. The meeting will also serve to bring together specialists familiar with these problems and industrial managers, in order to draw attention to available facilities for the transfer of aerospace information and technology, and to the need to ensure the dissemination of research information.

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CONTENTS

	Page
THEME	iii
PROGRAMME AND MEETING OFFICIALS	iv
	Reference
SESSION I – INDUSTRIAL INFORMATION REQUIREMENTS	
THE REQUIREMENTS OF INDUSTRY FOR TECHNOLOGICAL INFORMATION by M.W.Hill	1
LES BESOINS EN INFORMATION SCIENTIFIQUE ET TECHNIQUE – LE POINT DE VUE DU GOUVERNEMENT par S.C.Chambaud	2
REQUIREMENTS FOR LEGAL/ECONOMIC INFORMATION by J.M. van Poelje	3
SESSION II – MECHANISMS FOR INFORMATION TRANSFER	
LITERATURE MECHANISMS by H.Göehre	4
COMPUTER MECHANISMS FOR INDUSTRY'S INFORMATION TRANSFER by J.B.Fried	5
TECHNOLOGY TRANSFER FOR MANUFACTURING INDUSTRIES by D.F.Galloway	6
SESSION III – MANAGEMENT CONSIDERATIONS IN INFORMATION TRANSFER	
REVIEW OF SELECTED INFORMATION TRANSFER STUDIES by A.W.Pearson	7
INFORMATION TRANSFER COST/BENEFIT ANALYSIS by D.W.King and N.K.Roderer	8
EVALUATION OF INFORMATION SERVICES: RESEARCH AND REALITY by P.H.Vickers	9
SESSION IV – REPRESENTATIVE NATIONAL PROGRAMMES	
INFORMATION AND ASSISTANCE SERVICES TO THE MANUFACTURING INDUSTRY IN CANADA by G.Kirouac	10
A REVIEW OF TECHNOLOGICAL, TECHNICAL AND SCIENTIFIC INFORMATION SERVICES IN DENMARK – 1978 by K.Klintøe	11
PROGRAMMES NATIONAUX EN MATIERE D'INFORMATION INDUSTRIELLE (FRANCE) par M-F.Morin	12
A NATIONAL PROGRAMME FOR UK by J.B.Wilkinson	13
TRANSFERRING TECHNOLOGY TO INDUSTRY THROUGH INFORMATION by L.N.Mogavero	14

THE REQUIREMENTS OF INDUSTRY FOR TECHNOLOGICAL INFORMATION

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SUMMARY

The paper is based on the proceedings of a Workshop, "Transfer of Information for Industry", held in 1977 under the aegis of the Commission of the European Communities. Points made of that meeting are presented and reviewed in the light of other studies and of known attitudes of industrial companies.

"He sought, when it was in his power,
For information twice an hour".
Belloc.

Lovers of Hilaire Belloc's Cautionary Verses will recall that this quotation describes one of the attributes of "Charles Augustus Fortescue, who always did what was right and so accumulated an immense fortune". If I were to relate this to the topic which I was rather alarmingly billed in the leaflet advertising this meeting to be giving, namely "The requirements for scientific and technical information - the view of industry", it would be to draw attention to the fact that this was only one of the many diligent activities of Charles Augustus and that it was probably more a token of the character that led to success than itself the cause of success.

My actual brief is to describe and discuss the conclusions reached at a Workshop on Information for Industry held in Luxembourg last September (1977). This Workshop was held under the aegis of the Directorate-General of the European Communities responsible for Scientific and Technical Information and Information Management, including technology transfer, namely DGX111, and was organised by an ad hoc Committee,appointed by the Committee on Information and Documentation in Science and Technology (CIDST) to study certain aspects of Community wide needs of industry for information. The Chairman of this ad hoc Committee was Kjeld Klintoe. The theme of the Workshop was the "transfer into industry, particularly into small and medium sized enterprises, of information for industry".

The Workshop was a particularly interesting one which, it is to be hoped, will have had some influence on the direction of Commission policy. The deliberations were not confined to the narrow aspects of the theme and the recommendations produced ranged from the types of information required and its organisation into databases on the one hand through to the indoctrination of school and university students with an awareness of the potential value of means of exploiting information on the other. Nor were the requirements of large industrial concerns excluded.

Of course the views expressed at the Workshop, as will become obvious, do not contain anything remarkably new. In this respect it has to be seen as being another stage in the refining process which is the feature of successive major conferences on related topics. Probably one should single out in this respect the following meetings:-

Communication of Scientific and Technical Information for Industry.
FID/II Rome 1969

Government responsibilities in information for industry.
OECD Jouy-en-Josas 1970

Technological information systems and services for innovation
UN/ECE Balatonfüred 1973

The problem of optimization of user benefit in scientific and technological information transfer
AGARD Copenhagen 1975

Indeed, on rereading the papers of this AGARD/TIP meeting I felt that you may well find that this paper will not only recount the results of the CEC Workshop but also serve as a reprise of conclusions reached at your last meeting.

Looking at these successive conferences, including the Luxembourg one, there seems to be a gradual and natural development from emphasising the value of information and the need to establish or review, as the case may be, national policies towards the very practical aspects of getting the right information, in the right form, to the right man at the right moment. The announcement during the meeting that the DTO and the IIRS were to arrange an interchange of selected staff in order to exchange experience of actual information transfer practices is an example of this trend.

Now although, as Workshops go, the meeting was a large one and although those present had a wide diversity of backgrounds, there must remain some doubt about the extent to which the views expressed and the consensus opinions reached are truly representative of the wishes and requirements of so large and diverse a body as industry. It is probably not too strong to say that "The view of industry" is just as nebulous a concept as is "the opinion of the average man". Indeed, the views of industrial concerns may be even less easy to consolidate into a small set of widely held views when one considers how much more firms differ from one another than do human beings, even if firms are composed of human beings. Would one expect the multinational car firm, the large farm, the small printing firm and the one man building firm to express a united view on any topic, other than dislike of the tax system - and even then only unanimity in dislike, not on how to improve it?

It is, of course, because of just this impossibility of getting a genuinely concerted view on any constructive proposals for improvements that one has to make do with Workshops, such as that last September and the submissions from representative bodies such as Confederations of Industry and Chambers of Trade, and then to test the conclusions of the Workshops and syntheses of the submissions at gatherings of experts such as this present one. It is as if we must adapt the scientific method of conjecture and refutation, as propounded by Professor Karl Popper, to our field of study, ways of improving information exploitation by industry.

In order to provide some sort of touchstone against which to judge the validity of proposals made, I should like to start with a brief reminder of a few basic principles which apply to most industries, if not all, and then to remind ourselves of one or two of the equally basic relationships of industry to information.

Industry exists to produce or supply goods or services which people, or their organisations, want and want enough to be willing to pay for them. In the case of private industry (and even nationalised industry strives for the same objective) the want must be sufficiently strong for the customer to be willing to pay enough to cover all the production costs, plus a little extra which we call profit. Progress depends on the pressure of competition, though the ideas, which form the basis of improvements - whether ways of cutting costs, improving the product or even making new products - may often result from man's insatiable desire to try to improve things almost for the sake of doing it.

So one tenet of industry would seem to be that products worth marketing should pay their way. I am of course, ignoring short term market development exercises like "loss leaders" but this brings us to the next point, namely that industry is prepared to create a market for its products. In other words it will persuade customers that a product or service is something that they want and will pay for. Here we should not forget that products do not have to be essential to be saleable as long as they are so obviously beneficial that the users will pay readily for them because of their convenience or time-saving value. An example would be the automatic washing machine. It is not necessary but few households that can afford one would be without it.

So industry produces goods and services not only to meet stated wants but also to meet latent wants which it can activate by the well known marketing methods. Nevertheless, industry is usually cautious in its approach to new ideas. It is not the place of this paper to discuss the reason for this but the simple fact of life as far as many firms are concerned is that unless there is plenty of money available for taking risks - either from substantial accrued profits or from loans - such money as is available has to be devoted only to developments essential to commercial survival and to sure-fire winners. The consequences of this emerge clearly in the licensing market. Licenses are normally sought only for patented products and processes which have not only been developed to at least pilot plant scale but which have also a proven market. As has been said, "there is no shortage of ideas," - some 300,000 patented inventions each year prove this - but there does seem to be a shortage of the substantial resources needed to carry more than a small proportion of those ideas through the very lengthy and expensive period of development to production and marketing.

Because industry is always having to make ends meet, it is probably fair to say that it is not keen on Government schemes which cost a lot of money unless there is a clear financial return or other benefit. After all, industry is a major taxpayer and will have to contribute to any such scheme. That is not to suggest that industrialists are unaware of ther responsibilities for the general social good but if they are to endorse it they would wish to be convinced that any official service would be of real benefit to industry or to the community and had been fully thought through by the officials who

administer the service. In general, there must inevitably be the attitude that if a service is necessary, it should be possible to make it economically viable and hence it should be up to private industry to provide it and in the information field they would point to a number of successful private ventures such as ISI, SDC and Derwent. Nevertheless, it would also be generally accepted that there are some resources and services which have to be provided by the state (or by local government) - good roads, and sewage disposal are two about which there would be little argument - and, in the field of information, the national and public library services and the Citizen's Advice Bureaux are examples. In a recent report on Information Services in the Market Place, Birks (1) indicates that some information services can never be truly self supporting but must be sheltered under the umbrella of an organisation with other operations as well.

Already we have started moving from the basic premises of industrialists to their attitudes towards information. So before we plunge into ways of improving the information supply services let us just study for a moment the realities of information use by individuals in industry, for information is a raw material only for people or for their surrogates, computers. Daniel Bell has emphasised that we live in an age when the major raw material is information. It is a curious commodity which in some ways resembles machinery rather than raw material. One can use it over and over again without it getting used up; infact the more it is used the more usable it becomes. Also, like a machine, it becomes obsolete with the passage of time and has to be replaced by newer up-to-date information.

The raw material aspect was apparent in a paper by one of the Kellog International Corporation's executives, David Rowe (2), when he wrote, "The job (of an information officer) is not primarily to interpret or pass judgement so much as to make the information available in assimilable form to others in the organisation who, in turn, produce the briefs for decision making." I cannot help feeling that this view of an information officer as a high level filing clerk is indicative of a barrier to information flow. The manager may not realise that ready made solutions to problems could exist, which would save him the task of working out his own solution from first principles, and may not seek help from the information officer who appears to be relegated to a passive role.

Most industrial and commercial enterprises would agree that they need to receive information in order to operate effectively and they need to give information to promote both their sales and their "image", to use a now old-fashioned word. But they would differ considerably from one firm to another in what they need to receive and in what they should be expected to give, particularly the latter. It will be obvious that many firms will be reluctant to disclose manufacturing know-how or new lines of research, lest they aid their competitors. Perhaps less well known is the firm that is restrictive in its permissible sources of incoming information. An extreme example came to light during a project by the Canada Institute for Scientific and Technical Information (CISTI). The project officer was investigating why the referral service ASK had failed despite the careful market research carried out before starting and the publicity while it lasted. Many firms were contacted to find out why they had not used the service. The boss of one replied, "Lady, if any guy in this firm goes outside for information, he's fired!"

Essentially man has two basic abilities: one to do physical work with his limbs and body; the other to do mental work - i.e. to wield information. Effective man by nature seeks a blend of both activities, though modern trends tend to push him to one extreme or the other. Man the hunter had not only to follow and fight for food - he was too slow and puny to survive in that way alone - he had also to acquire, store and use quite a lot of information to trap and outwit his prey. Man the farm labourer may not process much information as he hoes between the rows of beets but when deciding the best time for sowing he has to use judgement based on the best information available, whether obtained by sacrificing to Demeter and reading the omens or by phoning that more sophisticated, if no more reliable, oracle the meteorological office.

The two extremes are both today observable in industry. The operator on the factory flowline, performing wholly repetitive movements almost instinctively, is not required to process any information at all. At the other extreme the Executive Director is concerned solely with processing information; his only physical activities would seem to be signing his name and lifting a telephone. Small wonder each seeks relaxation in totally contrasting activity.

My point here is that, contrary to the expressed view of many information officers that the firm doesn't view information work as important, the fact is that all levels of management are expert, the more so as one goes higher, at gathering and using information. Rowe (2) makes the same point. If, therefore, we feel, as we usually all do, that the available information resource is not being adequately utilised and converted into profitable industrial activity, it is necessary to ask ourselves very critically such questions as - whether the firm which should be using this information is already saturated with information and at the limit of what it can process. Or, is it that the information is not as useful as we imagine or just that the percentage return is too low? Or are there other factors, nothing to do with the supply of information, which prevent advantage being taken of its value? Or, finally, is there genuine ignorance of the untapped wealth of information which does exist and of ways of getting hold of it. On investigation it seems instances of each of these situations come to light.

Now it may be that in posing such questions we are in danger of generalising too much. One can find examples of both large and small firms which seem to acquire and exploit all the information they need quite readily: one can find examples of both large and small firms who apparently have great difficulty or else hardly try to acquire information. Two recommendations put to CIDST following the Workshop are of relevance here. The first was for a project comprising a series of case studies into situations where information was available and was needed but was not put to use. Not an easy project because it is likely to be difficult to find an adequate number of cases. The second was that publicity campaigns should be mounted to make the value of information more widely known and to provide a climate of interest which would make it easier to market existing and new information services.

The inherent inconsistencies in what I have been saying will be obvious. The following three statements illustrate this inconsistency:-

1. managers, executives, R & D staff are all predominantly information processors;

2. we feel that information resources are not being properly exploited either because there are inhibiting factors which are nothing to do with the information system or because the information is not as valuable as we think;

3. we should publicise the value of information.

I think we run into this problem because of the habit of generalising but in this case generalising by using, without qualification, the word "information." Occam's Razor is a good principle to adopt, provided it is appropriate. As Sir Montague Finniston, then Director of the British Steel Corporation pointed out (3), information consists of "facts - some established and others not; data and statistics - some substantial and others not; regulations - some legal, many confusing; and opinions - some sensible and others not." Some of the categories of information - for example opinions or theories on the one hand, numerical data or official standards on the other - have only very tenuous relations with each other.

Complicating this further, not only do different parts of industry need different types of information but within one firm different departments have very different needs. It may be that it is useful to distinguish between

(a) the types of information needed for the day to day running of businesses

(b) information needed for broad forward planning

(c) information needed for the solution of production problems

(d) information leading to newer improved products.

Generally, a & b require financial, economic, marketing, legal and social information whereas c & d are more dependent on scientific and technical information. Of course the categories are not mutually exclusive and some of the types of information may be needed in several of them but it may be of use to see which of these categories any improved service would serve.

Although it is certainly true that not everyone in industry sees any insuperable problem in acquiring the type of information wanted, those present at the Workshop were quite unanimous in agreeing that the problems faced by industry in general in this respect were serious and in need of urgent attention. Some firms, it concluded on the basis of the experience of those present, do not seek out and use information even when the particular problems they face could be made easier, perhaps even solved, by its use. Other firms, though aware of the value of information and equipped to retrieve and use it, find that so much of what they want is ill-organised for their purpose that valuable staff time is wasted.

One reason is that the mass and diversity of information needed is growing all the time. No longer is is sufficient to work out how to manufacture a product at a price people will pay. One has to comply with standards, with health or safety regulations both for the product and for the manufacturing process, one has to comply with environmental requirements and so on, and so on.

That the situation is not satisfactory in the eyes of many industrial experts has been underlined by a paper from UNICE (4) on the transfer of information to small and medium sized enterprises (SME's) which said:-

"(a) that SME's should be made more aware of the need for information

and

(b) a drive to make SME's more receptive to the possibilities of information would include impressing on them the importance of documentation and information in order to make them more competitive from the scientific, technical and commercial point of view."

In the scientific and technical field the scale problem is obvious and it is unlikely the majority of SME's would be able to benefit by being taught how to find useful technical articles. A few would benefit but the majority of these probably already have some idea of how to do it.

One reason for concern over the apparently low level of exploitation of technical information is the belief that a higher level of exploitation would result in a higher rate of development of new products in existing firms, in new industries and hence in more jobs. In a region like Europe which lacks mineral wealth and in which high standards of living, and hence high labour costs, prevail, continued economic prosperity must depend on industry remaining technologically advanced. Information supply and utilisation no doubt play important roles in industrial prosperity but the extent to which they contribute to new industries must be in some doubt. The recent Arthur D Little Report on New Technology Based Firms did not indicate that information exploitation was a major factor. Nevertheless there is no question that only by efficient use of information can industry operate efficiently.

The information that industry wants is generated by an immense variety of sources. Its communication takes place either in writing, whether by letter or publication, by other visual means (advertisements, television) or by oral transmission. I shall discuss some aspects of the channels of communication later. Let us first consider the information and its storage.

As is well known, there is a vast amount of information, many, many times more than even the multi-national giant companies will ever want. There is the familiar pattern, that is apparent in the use of literature in large technical libraries, that a small proportion of the information is heavily used, a large part used to a moderate extent and some hardly ever used at all; yet every so often an item from the third category proves quite invaluable. Industry, I think, regards the provision of large information stores as something that can only be undertaken from public funds and accepts that they can never be run at a profit. The extent to which the costs should be recouped is often debated.

In most Western countries the notion of free access to libraries is an inherent part of their modern culture. Free access to other types of extensive information store is, however, another matter. The principle seems to be that retrieval of information by one's own efforts should be free, whereas retrieval by means of human or mechanised intermediary has to be paid for.

Industry is not, at present, satisfied with the storage facilities and the inventories - the means of finding for one self what one seeks - that exist in all cases. Generally speaking, those for scientific and technical material are thought to be adequate, though two sectors - patents and standards - have come in for criticism. More important to industry's way of thinking are the other information sectors and in these both the storage facilities and the inventories (data bases are the modern form) need development. Priority areas identified by the Workshop included

market information, including evaluation of market trends

economic trends

product information

information on sources of materials

legislative information including case law, government regulations and local regulations

financial information

social requirements

environmental limitations

Although it is generally accepted that one man's meat is another man's poison or, if you prefer it, one man's relevance is another man's noise, I think many industrialists feel that the information problem - the problem, that is, of its great bulk - is, in part at least, due to the system containing too much information of low quality. When the M.D. calls for a report from his foreign sales department on market prospects in, say, Nicaragua he expects his staff to assess for him the worth-while evidence and discard that of low value - even though they themselves may have no direct experience of the Nicaraguan market. Similarly, even if the information warehouses (to use an OECD term) cannot act as his personal assistants or line managers in producing an assessed report, at least they should be able to store their information in a discriminating manner, thereby reducing the bulk that has to be searched. Repackaging is a step in the right direction, such as the Toxline service which melds entries drawn from CAS, BIOSIS and MEDLARS. As we all know, too much information is as useless as too little. In the field of validated scientific and technical information one asks what progress has CODATA achieved and are Information Analysis Centres proving worthwhile to industry? If one feels that information remains of value for only a limited period and that it should be discarded or relegated to special stores after that, this is likely to be practical only if the warehouses serve a wide but well defined clientele. The same information can be of value for a different period of time for different clienteles. On the basis that in the scientific and technical field there is, usually, no shortage of ideas and information, that product data should be confined to currently produced items, that only standards currently in force (or drafts of proposed future standards) are necessary for current production, industry would prefer to keep costs down by restricting information warehouses to currently valid

information and, as the Workshop emphasised, would prefer data banks to data bases whenever this is practicable. Of course, there will be some loss of information and perfect answers to questions will not always be possible but there is the pragmatic aspect that perfection has to be sacrificed in the interests of cost and of reaching decisions at the right time. Even in a library it is remarkable how often decisions have to be taken before all the information that one would like can be accumulated. In business (and a library is a business) timing is as overwhelmingly important as it is in politics.

The other requirement is that industry's information needs are often, to use the American expression, "mission-oriented" whereas all the information stores and most of the self-help retrieval systems are discipline or form oriented. As my colleagues in the patent licensing field confirm, it is rarely any use trying to persuade a firm to buy a licence just for a technical idea; the firm wants an integrated package of information, to establish that the idea has been properly thought through and researched, before putting a substantial investment into examining and testing its production and marketing feasibility. The same applies to straight information requests and it is to meet such needs for those firms which lack in-house information departments that the so-called information marketing services have grown up.

The industrialists and representatives of industry present at the Workshop accepted that there was a role, or perhaps several roles, which could be played by information marketing services - i.e. organisations, official or private, acting as intermediaries between the information stores or sources and the end user, the person who applies the information to the furtherance of his business activity. A very large number of such intermediary services are in existence, some as distinct organisations, such as the DTO, others as units within other bodies such as the member liaison staff of research associations and there are a wide variety of types of service, each industrial sector and each country having its own forms. I do not propose to go into all of these here: they will be well known to the audience and an outline survey of those in the European Communities has been undertaken for the Commission by Mr. K. Lomdahl.

What I do want to concentrate on is a set of criteria for such services which were propounded by industrialists at the meeting. They were that any information system, as used by the end-user in a SME, must:-

(a) give only the information the client wants

(b) give immediately understandable and applicable answers

(c) give answers quickly

(d) be simple to use

(e) involve only familiar technology - e.g. the telephone - if any technology is needed

(f) be readily accessible, preferably locally based.

(g) exploit existing tried, trusted and respected channels

(h) be stable

(i) charge fees which clients can readily afford.

Let us now take each one of these and briefly examine its significance.

(a) <u>give only the information the client wants</u>

On the face of it, this is so obvious as to need little qualification but experience shows that there are two pitfalls. The first is the client who, for any one of a variety of reasons, doesn't ask for what he actually wants or needs. Any information service must be capable of analysing the central problem and supplying, as far as it can, information to solve the client's real need. To give a simple illustration, the answer to a person who is having difficulty machining a metal part to a particular shape and is asking about milling machines may be to suggest the use of sintered metal components with the awkward shape preformed.

The second reservation is that this advice is excellent when the information service is operating in a problem-solving situation. It is more difficult to see its relevance to an SDI service. Probably the distinction needed is, 'who does an SDI service aim to help?' The Scientist, whether in university or in industry expects to spend a significant part of his time keeping up to date and absorbing information which may not be of immediate use; the development engineer has less time for such an activity; the man on the production side has virtually none at all. Yet even the last one has to be kept up to date with new developments. Success is likely to depend on timing. Many of my favourite examples of information transfer to the small firm are drawn from conversations with my friend Tom. Tom is a one man builder, surveyor and odd job firm, a mine of information and a perfect "technological gatekeeper" - the modern term for a "gossip" - to the world at large. For Tom and his fellow small builders, the source of technical information is the Builders Merchant's where you will always see a number of them waiting, elbows on the counter, to be served or for their order to be brought. And they swap problems and advice. SDI on new products (sometimes even methods) follows the line,

"Have you tried this new jointing compound? Look I'll give you a tin to try. Its great for aluminium pipes and copper but you may need to be a bit wary with lead." This may be followed by the views of those who have tried it and quite definitely Tom will express frankly the results of his trial - you call it "feedback." My point is that the SDI service operated at the moment Tom needed - but may not have asked for - jointing compound. He may only have been getting piping. An extreme example but I remember when I was involved in production in industry, the only items I responded to in the firm's internal technical SDI bulletin, were those I could put to use within a few days. After that time they were forgotten.

Which leads on to the second aspect

(b) give immediately understandable and applicable answers.

Even to the academic scientist, a string of references which he has to look up for himself can be irritating, though there are exceptions. For the industrial scientist, the sole use of any list is as a selection tool. When there are many references and he is being asked to define more precisely what he seeks, even then, to enable immediate selection to occur, more than just the bare bibliographic details are likely to be needed: a short summary or at least the terms used by the indexer.

Every industrial information officer knows that if asked by the production department what steels can be used in contact in the high test peroxide, he doesn't produce a list of references to studies of reaction kinetics of HTP/Steel interfaces: he provides the practical answer, preferably backed up by the HTP manufacturer's brochure plus, if he is a good information officer, information on how to passivate ('pickle' is the jargon term) the surface of the steel.

Also, and vital, answers must be couched in language the user can understand. This is a major aspect of repackaging. Consider drawing the answer to a technical problem, say the composition of a glass for a ceramic, from a patent specification and passing it on to the charge hand in a pottery in that same language. Grams may mean nothing to him, especially if he normally makes up his mixtures as parts by volume (one shovel of A, two shovels of B, mix to a slurry with half a can - what happens if he has to buy a new can and it is a different size? - of water and so on). Information must be in the vernacular used by the recipient for his normal work. In large firms the gradual translation between the scientific jargon of input to the research department and output as instructions to factory operatives or guidance to customers by the sales staff is done by chains of people, sometimes quite long chains. In some small firms, high technology ones usually, the owner or a senior employee can understand scientific terms. But these are few and in the majority of cases some intermediary service is needed to correct the information into an understandable form.

(c) give answers quickly.

Any information service dealing with industry direct should adapt this precept, whether its clients are large or small firms. Only spend a long time on a task if the client has clearly stated that he is prepared to wait and even then think twice before doing so. And if a delivery date is promised, stick to it at (almost) all costs: it is not only the product which should be reliable.

(d) be simple to use.

Complex information systems are for the expert information man, certainly not for users in small or medium sized firms. If, therefore, a complex system is inescapable, one's market is likely to be limited to large firms, government departments or research bodies with information departments and a handful of information intermediary services.

Although I acknowledge that many of my colleagues, more knowledgeable in such matters than I, disagree with me, I believe that one of the curses of present day on-line information services is that they are so complex that one not only needs a time-consuming course on how to use each one but also has to keep one's hand in by regular use of the systems. Nowadays we can take one simple driving test and can drive any make of family salon car without learning how to adjust the mixture, set the timing, get the spark gap right etc, etc. We can surely expect our on-line information systems to become simpler and simpler to use until they are, at the very worst, no more complex than those which bank clerks use so easily.

(e) use only familiar technology.

This does not mean that no progress will be made towards more sophisticated means of communication. Virtually everyone today uses the telephone for getting information but there is still a reluctance to use it to contact sources other than those we already know. If broadcasting regulations permitted it, walkie-talkie might have been the next step - it is already, as you know, widely used but only for a limited type of operations.

Incidentally, the mechanical answering devices may be invaluable for many situations, but their use by an information marketing service may have disastrous consequences; which brings me to

(f) be readily accessible.

Since information is usually expected quickly, it is a natural requirement that the supplying service should be accessible when wanted. This must be so obvious as hardly to need stating but examples of inaccessibility include not merely not having enough telephone lines (like all the London main line railway stations) so that one spends ages trying to get through but also being referred round and round an organisation to find the individual who can tackle your problem. There is a lot to be said for a locally based service to overcome a client's natural inhibition to phoning long distances for advice. It is not always avoidable but even with centralised services there must always be opportunities for client and service operator to meet and get to know one another.

(g) exploit existing tried, trusted and respected channels.

Personal contact, as just mentioned, is an important way to create the atmosphere of trust in the service and it follows that the personality of any information intermediary is of major importance. For this reason, any information storage and retrieval service should not think solely in terms of direct contact with the end user, even if the end user is large industry. It will commonly be better to plug in, if that is the right metaphor, to the channels already used. To use the example of Tom, sell your new product to the builders' merchant and direct your publicity at him rather than at Tom - who never reads circulars, adverts, journals or even most of his mail (he tells me he has, however, learnt to recognise final VAT demand notices; any others go unopened into the wastebin).

Alan, however, is different. He runs a small printing firm, reads one trade journal but is less extrovert than Tom and is quite disinclined to shout his problems around. He, he tells me, gets most of his new ideas from exhibitions.

In some countries, but not all, small firms get technical advice from bigger ones. This comes not only from those larger firms who are suppliers, for a vital part of a salesman's technique in winning orders against competition is acting as an (apparently) unpaid consultant, but also from those who are their customers. The extreme situation is, of course, where a small firm sells all its production to one client who makes sure that the little man is able to meet his requirements. When I was responsible many years ago for the manufacture of carbon granules for microphones we were constantly seeking better ways of testing quickly the quality of our product in terms which would indicate the expected performance characteristics over the extended periods of time which a microphone was expected to last. We received, to aid us in this, a considerable amount of information from the GPO and firms who manufactured the telephone sets, very little of which could have been obtained from the literature. In this, our laboratory staff acted as information intermediaries since, as a chemist, my knowledge of electrical appliances goes very little beyond how to mend a fuse.

While it is, of course, true that scientists in industrial R & D read the appropriate journals, or rather scan a sample of those they like, and look at the SDI bulletins produced by their libraries, and have properly formulated information searches carried out at the proper stages of each project, personal contact with the research world still remains a major source of information. It is a major source because printed information can never respond in that well known situation of one question leads to another. When working in industry with peroxide propellants I met at conferences most of the other workers in the field, especially those from government establishments and the academic world. More usable, applicable information was exchanged and ideas generated in an hour at those meetings than could be found in a dozen turgid research reports. The reports served to act as a record from which we could retrieve the numeric data we needed.

One method of linking industry with the world of academic research which was popular in the 1950's was the award by industrial firms to academic scientists of consultancies to them. I suspect the result was not particularly cost effective. Nevertheless one observes that many of the larger industrial companies do keep close contacts particularly with the technological universities and presumably find the consequent input of information worthwhile.

In any consideration of the channels, other than publications, of communicating scientific and technical information to industrial companies one must obviously include the Research Associations and Research Institutes. The Research Associations not only carry out research sponsored by their members but provide advisory services and indeed market information in the fullest sense of that term. Whether this is also true of the Research Institutes, I do not know but I doubt it. We heard at the conference from our Italian colleagues that the channels of communication between research organisations and industrial companies are not as effective as they should be and I am sure that it would be the view of industry generally that those research organisations which do not already readily interact with industry in the interchange of information should be encouraged to do so. There is an important requirement - those who act as the channel must be of similar intellectual status.

(h) an information service organisation should be stable.

There is, I think, an essential difference between manufacturers and suppliers of physical goods and suppliers of services, though the difference is certainly not clear cut. Whereas when buying goods one shops around each time to get the best quality at lowest price, one tends to stick with the same service supplier for a very long time. One retains the same bank, the same accountants and auditors, the same solicitors. Now an information service should fall into the same category as these other services (this is the one reason why I regret the use of the term information marketing service, it is redolent of an advertising agency which one does change for another every few years) and for that reason industry wants to be able to rely on their continued existence over a great many years. That is not to suggest that inefficient or unnecessary services should be kept artificially alive with heavy injection of funds. It does mean that their existence should not depend on political whim and that the old onesshould not be swept away just because a new network of such services has been thought up. I think industrial representatives might admit to a certain ambivalence at this point. While most industrialists prefer dealing with private concerns rather than official ones, if information services are to have the desired degree of ensured stability, many - not all by any means - will need to be supported by national or regional funds. Incorporation within soundly established bodies, eg a research association, a public library service or a chamber of commerce, may achieve this.

Perhaps it is worth adding at this point that just as industry expects the bank officials, accountants, auditors and solicitors who handle its affairs to be men of ability and standing, it expects those providing information services to be of similar calibre. Whether it always gets them is doubtful but some of the highly respected services one knows are particularly careful in this respect.

(i) Services should charge fees which clients can readily afford.

The Workshop spent quite a lot of time on the need for feedback to the information about the extent to which it was meeting its objectives and to which the objectives met genuine need. In the end there seemed to be a general feeling of agreement with Professor Shapero (5) that the only realistic way to get honest feedback was to charge for the service, even if government provided, and measure its effectiveness by whether clients buy the services. Birks (1) however casts doubt on this. Since information services rarely have to face competition from other similar services, the normal mechanism for keeping prices reasonably low and quality good, the pricing structure of official services should be kept such that users can afford it. UNICE has expressed the view that the tariff structure for EURONET should be such that users pay direct for services rather than having to take out a fixed price subscription. This cannot apply in every case and there are many examples of industries with fixed price arrangements for the supply of their services - thus simplifying accounting. But the general view seems to be that, wherever appropriate, payment for services actually rendered is preferred to fixed subscriptions.

In setting the level of charges, while the service should aim to be self supporting, it must be borne in mind that many of the people in industry who actually use the services have only limited authority where expenditure is concerned and the structure should be such that it can be used without each time having to seek higher level approval.

In expressing in this way the views industry has on the tariff structure we are touching again on industry's view of the role of government in the field of information supply. In general it would not, I think, be unfair to say that industrial directors, particularly in the larger firms but also many of the smaller ones, would go along with the conclusions reached at the OECD Seminar held at Jouy en Joses in 1970 which were, as summarised in an FID pamphlet,

1. continuously to evaluate the needs of industry for both technological and non-technological information,

2. to promote the use of information,

3. to co-ordinate initiatives in information and to support services not provided by the private sector,

4. to set up information wholesale warehouses,

5. to promote effective dissemination of the results of government R & D,

6. to promote R & D on information transfer.

Industry, to judge by views expressed by UNICE and its other representatives, would recommend that 2 be directed especially towards the small and medium sized firms. It would also add that international bodies like the European Commission have a role in enabling information enterprises, particularly private ones, to find the widest possible market for their service and to set up international channels for information transfer insofar as private enterprise is unable to do so.

Since I am now approaching the topic of the next paper at this meeting, let me end with a Parthian shot. The Workshop recommended strongly that to help the Commission to develop Euronet effectively an Advisory and Consultative Committee should be set up including both representatives of industry, i.e. the Confederations of Industry and Chambers of Commerce, and some members of actual industrial firms. Would it be unfair to say that if Government regards its role as to stimulate the industrial economy, industry feels it should be able to stimulate economy of government?

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LES BESOINS EN INFORMATION SCIENTIFIQUE ET TECHNIQUE: LE POINT DE VUE DU GOUVERNEMENT

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Tout d'abord il doit être clair que dans cet exposé je ne m'attacherai pas à analyser les besoins du Gouvernement ou des organes gouvernementaux en information scientifique et technique (comme pourrait le laisser penser le titre de la conférence) mais, par contre, je décrirai la façon dont un gouvernement peut analyser les besoins des industriels en information scientifique et technique et tenter de les satisfaire.

La première chose dont il faut prendre conscience lorsque l'on parle de besoins des industriels en information scientifique et technique c'est que ces besoins sont très variés et qu'il est loin d'être évident de réaliser un tableau mettant en correspondance le type d'entreprise et ses besoins en information scientifique et technique.

En effet, lorsque sur le terrain on pose la question suivante à des industriels: "quels sont vos besoins en information scientifique et technique", étant entendu que dans tous les cas on s'addresse à l'interlocuteur concerné, il apparait très vite que la réponse varie considérablement en fonction de la taille de l'entreprise considérée.

Il est possible, schématiquement, de traduire ces variations de la façon suivante:

Taille d l'entreprise	*Interlocuteur*	*Reponse*
Grandes Entreprises	Centre de Documentation	Structurée en termes d'I.S.T.
Moyennes Entreprises	Centre de Doc. Ingénieur chargé de la document.	Structurée en termes d'I.S.T. Structurée en termes opérationnels
Petites Entreprises	Patrons de l'Entreprise	Besoins en I.S.T.? Non!!

Evidemment cette présentation est tout à fait schématisée car bien d'autres facteurs ont un rôle important sur la prise de conscience des besoins en Information Scientifique et Technique de l'entreprise.

Ainsi il apparait clairement que le niveau technologique de l'entreprise est un autre paramètre essentiel, en effet il n'est pas rare de voir des petites entreprises disposant d'un centre de documentation parfaitement équipé, ces entreprises étant soit des entreprises travaillant dans des domaines technologiques de pointe (électronique, informatique . .) soit des sociétés de conseil (société de services, bureaux d'études . . .).

De même il n'est pas rare de voir de très grosses sociétés ne possèdant pas de service de documentation, on trouve en général ces sociétés dans des secteurs industriels traditionnels tels que l'industrie textile, l'industrie de transformation etc. . .

Un autre paramètre influe aussi considérablement sur la sensibilisation de l'entreprise à l'information scientifique et techniqué, il s'agit de la situation conjoncturelle, j'entends par là:

– est ce que l'entreprise est en période de déclin?
– est ce que l'entreprise est en période de croissance?
– est ce que l'entreprise est en période stationnaire?

Ainsi on peut donc dégager 3 facteurs essentiels qui influent de façon importante sur la perception du besoin en information scientifique et technique des industriels:

– la taille de l'entreprise
– son domaine d'activité
– sa situation conjoncturelle

Il va sans dire que cette liste n'est pas exhaustive et que d'autres paramètres existent, mais leur influence est moindre.

Cette première analyse fait apparaître clairement que le besoin en Information Scientifique et Technique n'est que très rarement ressenti en tant que tel par l'industriel.

Aussi importe-t-il de bien situer le rôle de l'information Scientifique et Technique au sein du monde industriel: l'Information Scientifique et Technique n'est pas une fin en soi mais un moyen de résoudre les problèmes, un outil, une ressource supplémentaire, à la disposition de l'industriel.

Aussi, afin d'analyser les besoins en Information Scientifique et Technique faut-il analyser les besoins exprimés des industriels et en déduire les besoins en Information Scientifique et Technique.

Les besoins exprimés sont fonctions d'un certain nombre de situations dans lesquelles peuvent se trouver un chef d'entreprise:

- Il crée une entreprise: Il devra alors déceler les créneaux disponibles, y adapter un produit, réaliser une étude d'opportunité.
- L'entreprise existe, mais son activité est en déclin, la seule solution pour elle est de se reconvertir: elle devra alors rechercher les créneaux d'avenir correspondant déjà à un besoin du marché et compatibles avec son savoir faire, choisir le produit adapté.
- Pour conserver le dynamisme de son entreprise l'industriel veut diversifier ses produits. C'est par référence aux moyens existants que doivent s'effectuer les choix: en premier lieu celui d'un créneau privilégié, en second lieu celui d'un produit adapté.
- Dernier cas: stimulé par la concurrence l'industriel veut développer une gamme de ses produits et la faire évoluer, c'est le cas le plus facile à traiter par l'entreprise, car elle est dans un créneau qu'elle connait techniquement et sur un marché qu'elle maîtrise, elle sait si ce dernier est porteur et par conséquent, elle peut mesurer la part d'efforts et d'investissements qu'elle doit réaliser.

  Elle devra cependant avoir accès aux connaissances et aux idées de produits disponibles (produits appartenant au domaine public, produits cessibles, transfert de technologies); cette prestation devra être complétée par un service en matière d'évaluation de produits (faisabilité, brevet abilité, liberté d'exploitation, marché potentiel).

Ainsi ces diverses solutions, si elles ne sont pas ressenties par les chefs d'entreprises comme correspondant à un besoin d'information scientifique et technique, à l'analyse il apparait clairement que c'est en fait essentiellement par l'information qu'elles se résoudront.

Donc, que ce soit au niveau de la recherche de créneaux, au niveau de la recherche de produits et de leur évaluation comme au niveau de la surveillance technologique, il est essentiel que l'entreprise dispose:

– d'informations scientifiques et techniques concernant la recherche et production,
– d'informations technico-juridiques couvrant principalement les brevets,
– d'informations technico-économiques à caractère commercial et marketing.

Quelles sont actuellement les resources à la disposition des industriels?

- *Informations scientifique et techniques:*
  - Les systèmes d'information bibliographique: ils donnent le signalement et n'analyse des articles de périodiques scientifiques et techniques français et étrangers. La plupart de ces systèmes, lorsqu'ils correspondent à un volume suffisant, sont automatisés et accessibles en conversationnel.
  - Les banques de données: elles fournissent des données chiffrées et évaluées et des renseignements technologiques qui présentent l'avantage d'être directement utilisables. Il en existe peu actuellement.
  - Les synthèses et états de l'art.
  - Les informations sur les recherches en cours.
  - Le savoir faire et les inventions cessibles.
  - Les produits et catalogues industriels.
  - Les normes et règlementations.
- *Informations technico-juridiques:*
  - Les brevets d'invention, par le monopole d'exclusivité qui leur est attaché constituent d'abord des facteurs d'intervention économique mais par leur valeur informative ils constituent également des véhicles de l'information technique.

- *Informations Technico-économiques et commerciales:*
  - Informations prospectives et études prévisionnelles à caractère économique.
  - Les habitudes de consommation, les marchés, la distribution.
  - Les statistiques de la production, des importations et des exportations.
  - Informations économiques et financières.

A partir des réflexions précédentes sur les "besoins" des industriels, sur les moyens d'information existants, il est possible de définir, au niveau gouvernemental, une politique d'intervention.

Cette politique devra donc s'adapter à la fois

– à la structure de la demande, elle-même directement fonction de la structure du tissu industriel,
– à l'infrastructure de l'offre existante, à l'environnement "informationnel" dans lequel évoluent les entreprises.

Elle devrait, dans le contexte économique et social qui est le nôtre, s'appuyer sur l'objectif suivant:

Dynamiser les entreprises, les inciter à innover afin de leur permettre d'affronter la concurrence internationale, avec comme principe de base:

S'assurer que l'ensemble du tissu industriel est irrigué de façon égalitaire, quelle que soit la taille des entreprises.

En fonction de ces diverses considérations, il est possible, au niveau gouvernemental, de définir une politique d'intervention afin de satisfaire les besoins en information scientifique et technique des industriels et donc de mettre en place les infrastructures et structures nécessaires.

Summary of the lecture by Mr. J.M. van Poelje, Deputy Director of the Economic Information and Export Promotion Department of the Ministry of Economic Affairs of The Hague, the Netherlands.

Gentlemen,

The first and foremost task of the Economic Information and Export Promotion Department is to supply Dutch trade and industry with such economic and commercial data as will enable firms to make a well considered choice of

a) what products to export
b) what markets or market sections to approach
c) what trade channels to use
d) what payment and delivery terms to stipulate
e) what media to use in canvassing markets.

On the basis of the choice made, an export strategy plan must be prepared for the approach, canvassing and watching of each market selected.
Another main task of my Department is to supply foreign firms with as specific as possible information as to the products, services and knowledge which Dutch firms are able to offer their partners in other countries. Small and medium-sized firms in particular operate according to the adage: "export what you can make in the short term; make what you can export in the long term"; they also call it 'marketing'.

For the purpose of this 'marketing' my Department is aiming as far as possible at collecting such information as firms need to make their plans for each market section and adjust them regularly. A dynamic entrepreneur should adjust his plans, say every two months, for the next six months on the basis of technical, economic and commercial changes. To be able to do so, he needs a great deal of information quickly. By definition the quality of a policy is no better than the quality of the information available.
Consequently we make a distinction between three major requirements which information must fulfil:

- **quality**
- **speed**
- **specificity.**

These are the starting-points of our information policy. It is the entrepreneur's essential task constantly to make new decisions and choices between alternatives on the basis of the information available to him.
To get the right information to the right firm fast there must be proper communication, both with the sources and with the users of the information. At the same time one must have up-to-date technological equipment for selection and processing of the mass of incoming data.

In view of the limited time available, I propose to develop my argument diagramatically as follows:

I. Sources of information
II. Kinds of collected information
III. Distribution of information
IV. Communication with sources
V. Communication with users.

I. Sources of information

The chief sources of information which we are using can be classified as follows:

1) **the Netherlands embassies. With 140 embassies the Netherlands is represented throughout the world, except in Taiwan and North Korea.**
2) **a selection of prominent economic daily newspapers, numbering about 30.**
3) **a selection of economic and commercial periodicals, numbering about 2,200, on the basis of products, services, countries and functions.**
4) **a library of some 100,000 scientific works on facets of economic developments.**
5) **the international and regional organisations.**
6) **own experience in the form of reports on study visits to foreign markets and other material.**
7) **incidental information obtained from personal contacts with diplomats accredited in the Netherlands.**

These are the chief sources and channels which are utilised systematically by my Department. I will now mention briefly the chief kinds of information.

II. Kinds of information

1) **all data on the economic business cyclical and economic structural developments in other countries.**
The areas which are studied are mainly:
   - **material short-term economic developments: production and consumption, gross national product and investment, imports and exports;**
   - **the socio-economic structure: employment, wage and price trends, cost of living, standard of living, purchasing power;**
   - **the financial economic structure: money in circulation, inflation, national budget, balance of payments, foreign exchange positions;**

- the production structure (sources of income, distribution of working population);
- the infrastructure: transport and communications, energy supplies, education;
- multiannual plans and development programmes;
- aspects of foreign markets: market approach, trade channels, commercial practice, conditions of payment.

2) statutory and equivalent regulations in the economic and commercial fields.
Mainly:
- trading and payment conditions
- import duties
- excise duties
- quality
- trademarks
- packaging
- health
- official forms and documents
- etc., etc.

Day-to-day information about these constantly changing regulations is of vital importance.

3) statistical data.
This information is notably important for obtaining an insight into the nature and size of the market or the structure of effective demand.
Moreover, the production and trade statistics contain indications as regards local and foreign competition in the markets in question.
Specimen of the statistical data collected by my Department are:
- population
- production
- trade (import, export, transit)
- transport
- finance
- national income
- expenditure
- wages
- prices (wholesale/retail)
- cost of living
- prosperity indices, etc., etc.

Although these data are meant to be used notably for information of all sections of trade and industry, they are used intensively also by the Department. On the basis of 12 macro-economic data an annual list is prepared of some 50 priority countries which are worth the special attention of trade and industry.

4) Central reference library.
Finally, the most extensive category of information on markets.
All abstracts are stored in a computer at a rate of about 700 every fourteen days. The technical processing is discussed in a separate survey.
I will only tell how the stored information is made available.
- bibliographic data base Informecon for on-line retrieval
- paper fiches for elected dissemination of information
- microfiches (computer output on microfilm)
- magnetic economic titles tapes
- Economic Titles, hard-copy abstracts Journal
- Key to Economic Science.

The reading rooms of the central reference library contain also a Periodicals Department and a Quick Reference Department with some 2,000 directories and yearbooks.

5) Prior information on proposed projects.
My department collects data of proposed or imminent industrial or infrastructural projects at the earliest possible stage through specially created channels. Some 120 items a week are brought to the attention of consultants, contractors, subcontractors and manufacturers in a special weekly bulletin.

III. Distribution of information

The reading rooms of the Library, Central Reference Library, Periodicals, Reference Books and Statistics departments are public so that anyone can come in and consult the available material. The staff will assist people who wish to study the material and collect data for themselves.
For distribution purposes the Department publishes periodicals with general information and with specialised information on branches or subjects, such as:

a) the "Wereldmarkt" (World Market) weekly containing general economic and commercial articles and a number of columns
b) weekly branch bulletins for eight branches (clothing, furniture, paints, foodstuffs, chemicals, machinery, packaging, trades and crafts)
c) a fortnightly bulletin on environmental questions
d) a weekly bulletin listing imminent projects
e) a bi-monthly reference paper called "Economic Titles"
f) a bi-monthly reference paper called "Key to Economic Science"
g) 16 quarterlies, entitled "Exportmarkten", on economic developments in 16 groups of countries in certain regions.

Other publications include special studies of individual countries, trade fair calendars, guides, catalogues and a loose-leaf vade mecum on import and export.

IV. Communication with sources

Under an agreement between the Ministries of Foreign Affairs and Economics, my Department is entitled to instruct ambassadors and other members of the Netherlands Foreign Service on what economic developments they are to report and what data to collect. A general instruction has been issued to that end and specific information is obtained daily by letter, telephone or telex.
Almost every week my Department invites commercial counsellors or secretaries for two-week working visits to the Netherlands. During the ten workdays they have informative talks at the Ministries of Foreign Affairs, Agriculture and Fisheries and Economic Affairs, and also with directord and staff of the Economic Information and Export Promotion Department.
In addition nearings and company visits are organised during which opportunities and problems of the markets in question are discussed with about 100 firms.
These working visits are scheduled according to a list of priorities which it is my duty to prepare. Furthermore there are regular contacts with heads of missions and with the Foreign Service Inspector, while our Department also plays a role in the training of new diplomats.
We also have personal contacts with the EEC Development Fund and with international, regional and local banks and financing institutions, which result in a smooth supply of information.

V. Communication with users

All modern media are utilised to bring the available information, events and facilities to the attention of as many firms as possible, either directly or through banks, accountants, branch organisations, export organisations, local Chambers of Commerce and Industry and export consultants. Some of these communication channels are used also to keep ourselves informed of the interests profile of trade and industry, or of branches or individual firms.

THE DOCUMENTATION CENTRE OF THE ECONOMIC INFORMATION SERVICE (E.V.E.)

The Economic Information Service of the Dutch Ministry for Economic Affairs was founded in 1936. So was the Documentation Centre. However it includes a library which dates back to 1907, and was the first special economic library operating in The Netherlands. Nucleus of the documentation service was a systematic card catalogue arranged in accordance with the Universal Decimal Classification (U.D.C.).

1) General literature documentation.
   This sub-department has the task of scanning publications published world-wide on business and economics and of making abstracts of the selected items for the computerized bibliographic data base Economic Titles/Abstracts, hard-copy Economic Titles/Abstracts and Key to Economic Science and managerial sciences (abstracts journal).

2) Branch documentation.
   Its task is to prepare seven weekly branch bulletins with world-wide market information, esp. meant for Dutch exporters in the following industries: chemicals, paint and coatings, textiles and clothing, food, furniture, machinery, packaging.

3) Literature information and research.
   This sub-department is charged with:
   - Information retrieval, including search by means of a computer terminal (video display unit), and in COM-microfiches.
   - Quick Reference Service with some 1.800 address books and reference works.
   - Advice on the selection and acquisition of new publications.

4) Administration.
   Including Order and financial administration, Lending Service, Book Storage and Secretariat.

5) Reprography and computer input preparation.
   Photocopies are made on request and periodicals are filed cover-to-cover on microfiches. The written abstracts of the literature documentation are processed into computer input format.

PUBLICATIONS

1) Economic titles/abstracts
   A semi-monthly journal of abstracts covering nearly every conceivable subject in business and economics, and a wide geographical range. The items are taken from some 2.000 periodicals plus books, reports, a.s.o., published world-wide. Each issue contains some 550 references arranged by the Classification system of the Centre, a thesaurus by subject field based on the Universal Decimal Classification (U.D.C.).
   The reference includes:
   - U.D.C. number
   - alphabetical codes indicating form of publication, grade of difficulty and language
   - one to five descriptors (in English)
   - title
   - bibliographical data and
   - abstract in the language of the original publication: mainly English (52 %), Dutch (18 %), German (20 %), French (9 %).

About 80 % of the references concern articles from periodicals. Some 100 journals in the field of economic science are processed cover-to-cover, with the exception of articles on pure mathematical economics, studies of an extremely local interest, and short notes.
The English descriptors are used for the computer prepared subject index at the back of each issue. These subject indexes are cumulated per annum. Economic Titles/Abstracts is computerized and tapes are available.

2) Key to Economic Science and managerial sciences
A semi-monthly abstracts journal containing abstracts selected from Economic Titles/Abstracts (15-20 %). Key to Economic Science and managerial sciences is a continuation under another name of "Economic Abstracts", which dates back to 1953.
Each issue contains about 120 abstracts of an academic character.

3) Information bulletins, containing abstracts in the language of the original publication, and bibliographical data. Short items are reproduced entirely. Key words are added, but not indexed.

a. "Milieu", semi-monthly bulletin on environment and pollution.
b. "Handel , ambacht, dienstverlening, toerisme, midden- en kleinbedrijf", weekly bulletin on retail trade, consumer markets, services, tourism, small and medium enterprises.
c. Seven weekly branch bulletins.

AUTOMATION

The automation project in co-operation with the Government Computer Centre in Apeldoorn was initiated on January 1st, 1974 with the computerized production of the Economic Titles/Abstracts hard-copy. Magnetic tapes were stored and used to compile the bibliographic data base called Economic Titles/Abstracts (March 1975).
Since then the data base has been added to regularly. In December 1977 this data base contained some 55.000 abstracts, growing at a rate of approximately 600 semi-monthly (the abstracts published in Economic Titles/Abstracts + some additional material).

On-line retrieval

In July 1975 an on-line terminal (video display unit) with printer was installed in the Documentation Centre in The Hague to conduct retrospective literature searches on Economic Titles/Abstracts. I.B.M.'s STAIRS storage and retrieval system is used. February '77 a dial-up experiment was started for corporations and institutions interested in on-line retrieval on the data base Economic Titles/Abstracts, using the Government Computer Centre's facilities.
Dial-up facilities on international data base systems are still in the negotiation stage and are conducted through the specialized on-line information intermediary Learned Information (Oxford) Ltd., who also have an exclusive license for marketing Economic Titles/Abstracts magnetic tapes outside the Netherlands.

Microfiches

A.C.O.M.-service has been developed (Computer Output on Microfilm). Microfiches are available containing abstracts, arranged by U.D.C.-number, as from January 1st, 1974. On each microfiche appr. 1.700 abstracts are recorded (plus an index).
The abstracts are those published in Economic Titles/Abstracts cumulated and permutated for each U.D.C.-subject code + all additional material put in the data base.

Current awareness service (S.D.I.)

In the second quarter of 1976 the documentation cards service was computerized. Paper fiches corresponding to a client's interest profile are selected twice a month. (These paper fisches are usually called S.D.I.-fiches; S.D.I. = Selective Dissemination of Information).

"LITERATURE MECHANISMS"

Information Management in Industrial Organizations

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Summary

Transfer of information in industrial organizations comprises three different problem areas—the utilization of external information for internal purposes, the internal transfer of information and the utilization of internal information for external purposes. In the performance of information transfer there is to differentiate between the direct flow of information and the indirect one which requires intermediate information stores such as libraries and archives to be called upon as required.

Industrial organizations require a large number of information most different in type and for the most different purposes. Today, out of the complex information requirements the share of technical and scientific information has already become comparatively small and is further decreasing. The reason lies in a fundamental change in the means and ways of motivating technological action which results in consequences hardly recognized by now. In classical interpretation technological development used to be synonymous with the progress of humanity. It was the task of industry to find and realize possibilities of usefully applying technical inventions. This task has more and more been changed in recent times in that existing problems are first made apparent which then might be solved by contributions of engineering. The impulse for changes no longer stems from technological inventions but from system and problem analyses with their specific, often non-technological information requirements. Technology has more and more lost its importance as the motor of progress in order to become a tool for solving problems.

A basic change is also to be observed in the valuation of information channels which are used for information transfer. The classic channel, i.e. "publication"—in the form of a lecture at an experts' meeting or in technical/scientific journals—is losing more and more of its significance. However, the private channel and the semi-public channel that is usually limited to a certain group of scientists or engineers as well as the public channel that comprises the mass media and the still insufficiently recognized channel of the so-called "gray" literature are gaining more and more in importance.

The most important barriers to efficient information transfer are the underdeveloped information-consciousness of many scientists and engineers but even more so of the industrial managers on the decision-making level, as well as specialists' laziness about writing and last but not least the limited capability of the average information-consumer to intellectually digest the overwhelming flood of information. In addition, there are barriers to information transfer in practically all of the information channels, which can and must be eliminated. In consequence of these considerations there remains the urgent requirement to develop and put into practice new forms and structures of systematic Information Management.

1. INFORMATION TRANSFER IN INDUSTRIAL ORGANIZATIONS

1.1 Production factor "Information"

Industrial organizations pursue their objectives by the combined employment of the fundamental production factors

- o capital
- o labour
- o working material (capital goods)
- o material
- o energy

It is the task of management—the so-called "dispositive factor"—to employ these production factors as effectively as possible. This requires the transfer of a great number of information of the most varied nature. For this reason, there has been a tendency of late to consider the factor "information" as an additional fundamental production factor.

The employment of the classical production factors has been largely rationalized through efforts carried on for decades. Generally speaking, it is difficult to take a lead in competition only by better employing these factors. However, this is not the case as far as the hitherto neglected "competitive factor information" is concerned. If this factor is taken into account there may still be a chance to take the lead in competition with relatively small expenditure.

Employment of the production factor "information" involves three different problem areas concerning information transfer:—

- o External ⟶ internal information transfer (utilization of external information for internal purposes of the organization),
- o Internal ⟶ internal information transfer (utilization of internal information for internal purposes),
- o Internal ⟶ external information transfer (utilization of internal information a) for external purposes of the organization, b) for purposes of the general public).

In practice, there result different problems—depending on the nature of the transfer—and, accordingly, different methods to solve these problems.

1.2 Direct and indirect information transfer

From an organizational, methodical and technical point of view, there are to be distinguished:—

a) The direct information flow between information source and information consumer:—

- o as a phenomenon accompanying a process,
- o in the control loop of control processes,
- o in the social communication process (standardization of behaviour, motivation, co-operation);

b) the indirect information transfer via intermediate stores. The reasons for such an intermediate storage are the following:—

- o difference in time between information supply and demand,
- o securing of knowledge and experience—independently of persons,
- o legal and contractual obligations of safe custody and proof,
- o uncertain circle of addressees.

In this sense "literature"—more exactly "specialist literature"—is an intermediate store for scientific/technical findings and experience distributed among numerous libraries and documentation centres throughout the world.

2. INFORMATION REQUIREMENTS AND TECHNOLOGICAL ACTION

2.1 Technology as the motor of progress

For centuries, technological action had been exclusively governed by the fundamental requirements of mankind. Its purpose was to safeguard the security of existence, to facilitate work, and exercise power.

With the beginning of the industrial era, technology had more and more become the motor of progress of civilization. The predominant objective of technological action was to turn scientific findings and technical inventions into economic profit.

This conception makes understandable the great interest the classical industrial organizations have taken in the scientific/technical literature during the past decades. Even today, the system of our libraries and documentation centres still takes this classical literature requirement by science and industry into account.

Recently, the interest of the industrial organizations in the classical specialist literature has decreased continually. The foreground interpretation of this phenomen is that the information supplied via the classical channels, i.e. "specialist journal" and "specialist book" lacks topicality. The underlying reason, however, may be the beginning of a fundamental change in the means and ways of motivating technological action and in the conceptions on which it is based. This change finds its expression in current slogans like "innovation", "system thinking", "systems engineering", and "system management".

2.2 Innovation

As far back as in 1912, Professor Schumpeter, one of the pioneers of modern management science, pointed out that considerable resistance has to be surmounted to convert technical inventions into economic profit. The process of surmounting such resistance—and not the process of conversion itself (!)—was called "INNOVATION".

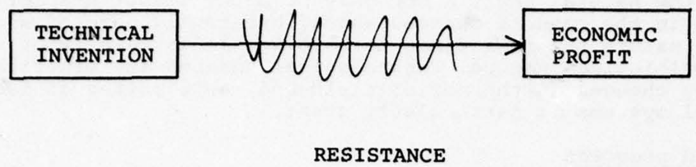

Fig. 1: CLASSICAL NOTION OF INNOVATION

Today, this notion has been extended to mean the process of surmounting resistance when converting any new idea (e.g., of a technical but also of a methodical, organizational, social, political, or ecological nature) into any kind of general profit.

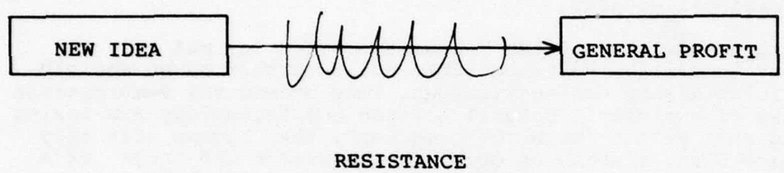

Fig. 2: MODERN NOTION OF INNOVATION

2.3 Innovation defined as a system change

What does actually happen when new ideas are converted into "profit"? Why is there almost always resistance to be overcome?

To begin with, the following has to be established: new ideas are always introduced into an existing system. This system may be of a technical nature, but also of an organizational, economical, social, political, or ecological nature. Prior to the introduction of the new idea, the system concerned (A) is in a certain initial state (A1). After the introduction of the new idea it is in a new state (A2) which is different from the initial state. It is generally assumed that the new state aimed at is in some way "more profitable"/"better" than the initial state—an assumption which more and more meets with scepticism.

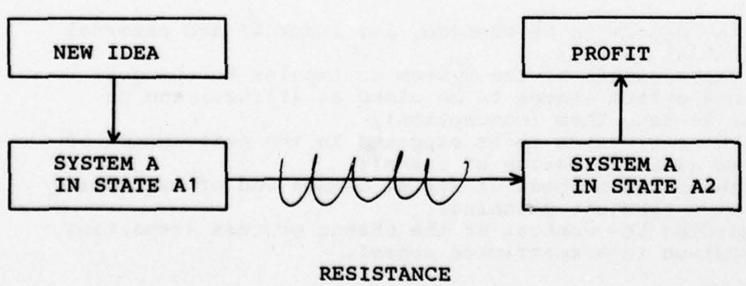

Fig. 3: INNOVATION DEFINED AS CHANGE OF SYSTEM STATES

"INNOVATION" as discussed above is to be understood as the "process of transferring a certain system from a given initial state to a new (more profitable/better) state".

Occasionally, management of such change processes is directly called "change management". Usually, however, one speaks of "programme management" or "project management".

The resistance that has almost always to be overcome when implementing changes is based on the natural inertia not only of material but also of social systems. Even in the case of changes which, apparently, are of a purely technological nature the resistance to be overcome is chiefly of a psychological and sociological nature. Technological changes are practically always accompanied by changes in the social field—and, as a matter of fact, the inertia of social systems is particularly great.

2.4 System management and progress

There are two different types of "system management":—

- o The management of an existing system—including its gradual, evolutionary change (quasi-static system management)
  Example: the classical, hierarchical management of an industrial organization;
- o the purposive, more or less sudden transfer of an existing system from a given initial state to a new state which is substantially different from the initial state (dynamic system management). Examples: reorganization of a company; merger of two companies; containerization of the transport system of a national economy.

More and more, such models of system management determine not only the technological but generally the responsible action within human society and within the relationship man—environment. They become the determinants for the "progress of humanity". Natural science and technology are losing their dominating role as the "motor of progress". They become what they always should have been: a means of obtaining knowledge and tools of a deliberate system management on the way of humanity to a better future.

2.5 Conclusions concerning the information requirements

For the quasi-static management of an existing system—e.g. an industrial organization—the following information is required:—

- o information to fix the objectives of the system (enterprise) and their attainment;
- o information on the inner state of the system (enterprise), its subsystems (organizational units) and elements (production factors), on the interaction of its elements and with the system environment;
- o information which is the prerequisiste for the employment of the production factors, such as knowledge of languages and expert knowledge for the employment of the "labour" factor, or legal information and financial data for the employment of the "capital" factor.

Practically all of this information is also needed for the dynamic system management in the case of purposive changes of existing systems (i.e. for the programme/project management). In addition, the following information is required:—

- o information on the system to be changed, its internal and external interactions (initial state);
- o information on the response of the system to impulse to changes;
- o information on new system states to be aimed at (target) and on possible ways to achieve them (conception);
- o information on the resistance to be expected in the performance of the system change (identification of risks);
- o information on means and methods of system change and of overcoming possible resistance (project planning);
- o information regarding the control of the change process (reporting, project documentation in a restricted sense).

Systems to be changed may be the own company organization (internal programmes/projects) but also external systems which are to be changed by means of the own organization. The latter is the normal case in the aerospace industry which is oriented toward management of respective programmes and projects.

Typical activities in preparing programmes and projects are system studies, problem analyses, feasibility studies, conception, and planning activities. They reveal, among other things, information gaps which might exist and which have to be filled up prior to proceeding with the programme or project. The current information requirements thus generated are in general rather comprehensive—depending on the size and complexity of the systems to be investigated.

Even with technical projects, there is a tendency that the problems and risks (and thus the information requirements) shift to psychological, sociological, economical, political, and ecological fields. In addition, a greater need for systemoriented information instead of discipline-oriented information has become apparent. Only few of these requirements can be fulfilled by means of the classical technical/scientific literature. The lack of topicality of the relevant literature is a further negative item to be mentioned in this connection.

2.6 Meeting the information requirements

The majority of national and international information systems today are of a discipline-oriented nature. For this reason, the system-oriented, interdisciplinary information requirements of modern, project-oriented, industrial organizations can be met by these systems only to a highly unsatisfactory degree.

A further aggravating circumstance is the fact that neither the individual manager on the decision-making level nor the individual specialist in a project team is able to take in the complexity of problems inherent in the programmes and projects. This results in the additional problem of "qualified information for the qualified non-specialist" which a priori cannot be met by the classical specialist literature.

Besides, even the best supply of information greatly fails its purpose if the recipient of the information is lacking the basic knowledge that is necessary to evaluate and use the information supplied. Even an excellent specialist knowledge does not help much if system information has to be processed and the system knowledge required for processing is not available. Even utilization of pure specialist information may fail if the necessary specialist knowledge does not reflect the state of the art of the respective specialist discipline.

In this respect, "education and training" are inherent parts of the general problem of information. As far as industrial organizations are concerned, the specialist training, on the one hand, and the conveyance of system knowledge and knowledge of methods with regard to the realization of system-changing programmes and projects, on the other hand, are of special importance. Accordingly, information for education and training constitutes a significant part of the information required by industrial organizations.

3. CHANNELS FOR INFORMATION TRANSFER

3.1 The classical channels

The classical channel for the transfer of specialist information is a "PUBLICATION". It is either in the form of a lecture at an experts' meeting (conference, congress, symposium, colloquium, seminary, etc) or in the form of an article in a specialist journal or a specialist book.

A lecture is probably the most topical form of publishing new findings and experience. Disadvantages to the author are the expenditure of time and work required to prepare the lecture as well as the manuscript which, in most cases, is demanded. Disadvantages to the participant of the meeting are the abundance of such events and the lack of transparency of the events offered, the expenditure of time and travel, and the ephemeral character of the information conveyed. Disadvantages in general are the limited circle of participants in such events as well as the language problem. The advantages offered in return are the relative topicality of the information conveyed as well as the opportunity for discussion.

The generally type-written manuscript copies of the lectures rank with the so-called "gray literature". In most cases, they only reach the participants of the meeting, however, efforts have recently been made to make them accessible to a wider circle of readers. Their possible subsequent entry into literature—be it as an article in a specialist journal or in the proceeding of the meeting—would involve all advantages and disadvantages of information transfer through this channel.

The specialist publication—in the form of article or book—is certainly the most wide-spread classical type of publication and, among university graduates, often the only channel that is recognized. Its advantages are the wide-spread (often world-wide) dissemination as well as, owing to the work of numerous libraries, its "everlasting value"—obtained by storage for permanency—as part of the "knowledge of mankind". Less favourable are the lack of transparency of the relevant supply, the low topicality of the information conveyed (delay of 6 to 12 months in the case of specialist journals, 1 to 2 years in the case of specialist books), the relatively high expenditure of time and work on the part of the author and the publishing house, and the language problem.

Generally speaking, the following can be said with regard to the two classical channels of information transfer:—

- they are choked up to a large extent,
- the topicality of the information conveyed leaves much to be desired,
- the communication between information source and *information consumer* is disturbed (it is only with difficulty that the author reaches the circle of persons whom he wants to address; it is only with difficulty that the recipient—through troublesome checking of intermediate stores—finds the information he requires).

3.2 Non-classical channels for information transfer

In addition to the classical channel of information transfer, i.e. publication, there are further channels. They are partly favoured by recent technological developments in the fields of communications engineering, reprography and data processing, as well as in the field of transport (motor-cars, air traffic). However, in most cases only a limited circle of participants in the special type of information transfer benefit from these advantages.

In particular these non-classical channels are:—

- the private channel (personal talks, telephone conversations, correspondence);
- the semi-public channel (discussions, meeting; participation in committees as well as in programme and project teams; minutes of meetings, working documents);
- the channel of "gray literature" (mostly type-written *copies—studies*, expertises, comments, reports, etc.);
- the channel of mass media (acutal information of temporary importance for the non-specialist);
- the channel of patents and standards (of increasing importance also as a technical source of information);
- the channel of data transmission from and between stores of electronic data processing systems.

Favoured by the development of the communications system and by improved traffic connections, the non-documented, "informal" information transferred through privat and semi-public channels will continue to play an important role. All other channels of information transfer have to be measured against the efficiency of the informal information system, with which they are competing.

In the age of system and change management with its numerous programmes and projects, the so-called "gray literature" grows more and more important. The results of the projects are reflected in a multitude of often comprehensive studies, expertises, and comments—above all, however, in progress and final project reports, with the enormous quantity of technical and other documentation that are hidden behind such reports. It is this very field that offers numerous starting points for an improvement of information transfer, in particular with regard to a better accessibility of such documentation to the general public.

Under the aspect of a growing system orientation, the significance of the mass media is even increasing, both for the specialist and the management. They convey—at least partly—the background information and the system knowledge concerning the higher-ranking economical, political, and social systems in which also technological decisions and technological action are embedded.

4. BARRIERS TO INFORMATION TRANSFER

Barriers to information transfer may be encountered:—

- o at the information source—i.e. during the generation and acquisition of information and its conversion into a form suited for the information transfer;
- o in the channel used for information transfer;
- o with the recipient of the information—including the conversion of the information into "right" decisions and "right" action.

Even at the source of information there are such barriers, e.g.:—

- o conversion of insufficient informal information into documented information,
- o expenditure of time and work required for the documentation,
- o deficiencies in the acquisition of important data and information,
- o problems of data protection and secrecy as well as of the intellectual and industrial property of information,
- o editing of information in a form which is not suited for the recipient of the information,
- o problems of language/standardization,
- o insufficient condensation of information,
- o insufficient input of information into the channels of information transfer and/or into information stores that are accessible to the general public (clinging to the information, considers it as private property—according to the motto: "Knowledge is Power"),
- o input of information into the wrong transfer channel and/or the wrong store,
- o ignorance of the potential recipients interested in the information concerned.

Barriers encountered in information channels are:—

- o choking of the channels caused by excessive supply of information,
- o insufficient topicality, completeness, and reliability of information,
- o lack of transparency of the information supplied,
- o addressing of the wrong circle of recipients,
- o operating expenditure of the transfer channel,
- o gaps in the supply of information,
- o insufficient orientation of the supply of information towards the actual requirements of the recipients,
- o insufficiently developed, badly organized or even lacking channels for the information transfer (e.g., the deficient horizontal information transfer in organizations having a hierarchical structure with a chiefly vertical information flow).

Significant barriers also exist on the side of the (potential) recipients of information:—

- o insufficient, often too specialized expert knowledge, lack of system knowledge and knowledge of methods, lack of problem-consciousness—partly associated with arrogance and ignorance;
- o lacking or underdeveloped information-consciousness;
- o too high expenditure of time and work for the search for, and acquisition of, information;
- o scheduling and deadline problems;
- o limited capability of man to intellectually digest information.

The last point, the limited capability to intellectually digest information, is doubtless the decisive barrier to the transfer and use of information. An attempt to overcome this barrier is the continuously increasing technical specialization. If this is carried on, we will not before long be faced with a babel of tongues—one specialist simply no longer understanding the other. However, this would also mean losing the capability to solve complex problems of an interdisciplinary nature.

The modern counter-movement to this fatal development is system orientation, thinking in systems and system management. It tries to escape from the dilemma by creating teams with members of various disciplins. However, everybody who once was a member of such a team knows what difficulties may be caused by the barriers encountered within the team, such as different technical languages as well as different technical approaches and methods of thinking.

We urgently require the professional, interdisciplinary "integrator"—as an indispensable complement to the "specialist". The integrator must be capable of understanding the technical arguments of different specialists, to translate them from one technical field into the other, and, finally,

to intellectually integrate the technical fields to form a complete whole. In the long run, only the combination of technical specialization and interdisciplinary integration will succeed in overcoming the barrier of the limited human capability to intellectually digest the flood of information.

5. INFORMATION MANAGEMENT

5.1 Information, documentation, and data processing

The "data processing" departments in industrial organizations consider themselves mostly as "special departments for the application of data systems engineering" which perform relevant services for the different organizational units. These services comprise the operation of the computers (hardware, operating system, utility programs), on the one hand, and the elaboration of "problem solutions" by means of data systems engineering for all other departments of the organization as potential "customers", on the other hand. Generally, such problem solutions consist of special EDP programs or whole program systems—possibly combined with special hardware configurations.

If a problem has thus been solved, the relevant programs are handed over to the respective "customer" who, subsequently, operates these programs under its own management and responsibility. In this way, the data processing department does not assume any responsibility for the functioning of the information system of the company—the responsibility rests entirely with the respective "customer".

From a technical point of view, to date data processing has been almost exclusively limited to the field of numerical information, although there are some approaches to also process graphical information. On the whole, however, it can be said that in most of the data processing departments of industry the vast field of processing non-numerical information (in the form of texts, graphical and pictorical representations—also in combinations) has been hitherto neglected, although the share of numerical information in the total of information generated and/or required by an industrial organization is hardly more than 10 %.

In addition, the data processing departments of major industrial enterprises often continue—partly under the influence of certain manufacturers—to exclusively pursue the conception of large-scale computers in conjunction with the conception of a strong organizational centralization of data processing. Under the influence of this conception, the recent developments in the fields of medium- and small-size data systems engineering as well as engineering of micro-processors are hardly noticed, if not even rejected. Yet, it is these engineering systems that offer possibilities of an organizational decentralization which (from the point of view of avoiding an excessive bureaucracy, especially in large organizations) should by all means be made use of. Besides, in the field of processing non-numerical information it is these engineering systems that seem to offer advantages compared with the large-scale computer.

On the other hand, in most of the major industrial organizations the field of activity "information and documentation" has been limited to date to the classical activities of the organization's own library, documentation centre, and reporting department. An additional department charged with the tasks of internal "information analysis centre" is already considered particularly modern and progressive.

As a matter of fact, however, the field of activity "information" does not cover only classical specialized literature and similar "reports" but also all types of information media, patents and standards to working papers, correspondence, and informal information in numerical as well as non-numerical form.

Part of the field of activity "information" is "documentation". It deals with "documents", i.e. information which—more or less permanently—is fixed on suitable data carriers (even today chiefly paper, increasingly also photographic material). The classical documentation is restricted to making accessible and administering documents of the classical literature, of late also the gray literature.

This field of activity must be enlarged, too, to include all types of documents, on the one hand, and all activities relating to documents, on the other hand. "Documentation systems engineering" in this sense should cover:—

- o The techniques of preparing documents—such as wording, dictating, writing, drawing, photographing, filming, sound recording, video technique; graphical design, correction and revision of documents; copying, printing, etc.
- o The techniques of handling documents—such as acquisition, making accessible, storage, administration, transfer, and distribution of documents.

- The techniques of evaluating documents—in particular, the condensation of the information contained in the documents as well as its conversion into the form adapted to the respective problem and user.

On the wohle, it seems to be necessary—and unavoidable for the future—to enlarge the "data systems engineering" to create "information systems engineering". To be included in the future organizational unit "information systems engineering" are communications engineering as well as documentation systems engineering in its enlarged sense as discussed above, i.e. including "office engineering", graphics, audio-visual techniques, and reprography.

5.2 Information Management of industrial organization

To command information systems engineering and to make available relevant hardware and software and the required expert knowledge in the field of information systems engineering within an organizational unit "information systems engineering" do by far not guarantee the functioning of the information system of an industrial organization.

Industrial organizations (as well as other major organizations, e.g. public administration agencies) are still lacking a department which is responsible for the effective employment of the factor "information" to obtain the objectives of the organization, just as the finance and accounting departments are responsible for the employment of the production factor "money" (capital), the personnel department for the employment of the production factor "personnel" (labour), and the materials department for the employment of the production factor "material". The problematical nature of this fact results in the question:—

> "Who actually takes care that, inside and outside the organization, everyone who requires information in the organization's interest in fact receives it at the right time and in the right form and, further, that the information system of the organization altogether works efficently from an economical point of view?"

What we need is a central organizational unit "information management" which—not only temporarily but as a permanent task—develops and implements the information system of the organization concerned and which is responsible for the efficient, reliable, and economical operation of this information system.

This does not imply that all relevant activities have to be performed by this organizational unit itself on a central basis. Its tasks are primarily of a planning, controlling, and supervisory nature and include also the execution of projects. The relevant tasks and activities should—to the greatest extent possible—be delegated and carried out on a decentralized basis. Central performance of tasks should be limited to such activities which cannot be decentralized for reasons of efficiency. However, even with the highest degree of decentralization, the central organizational unit Information Management remains fully responsible for the correct functioning of the information system of the organization as a whole. It shall be vested with sufficient authority to issue instructions to the decentralized departments in order to be able to intervene whenever the functioning of the information system as a whole is concerned.

The existence of a centralized hardware is not a prerequisite for the proper functioning of the information system of an organization. On the contrary—the possibilities of decentralization offered by modern information technology should be made use of wherever this is possible. However, what is desired and in the long run unavoidable, is the connection of the decentralized hardware to an integrated system. Allow me to put in an analogy in this place: The information system of an organization corresponds to the nervous system of an individual living creature. While the latter functions automatically, the information system of an organization has to be systematically set up and operated.

A prerequisite for the efficient information flow within the organization as well as between the organization and its environment is that the terms and definitions used are employed everywhere with the same meaning. Standardization of terms at the semantic level is therefore a must. This is one of the most important tasks of Information Management which is to be carried out on a central basis.

Not absolutely necessary is the standardization of the software to be employed throughout the organization or even the development of standardized program systems throughout the organization—e.g. for the control of development and manufacture. Uniform program systems could on the one hand provide for rationalization by avoiding duplication of work; on the other hand, such systems will become too complex and hardly manageable because every conceivable case has to be taken into account beforehand—even it is only of local interest.

Thus it is preferable to develop different systems which consider the respective local situation and to interconnect them—if necessary through suitable conversion programs.

A further, significant task of information management is to serve as a central information switchboard both of internal information and of information to be exchanged between the organization and its environment. For external information institutes, the Information Management of the organization is the central liaison and co-operation party.

The conclusions drawn from these considerations are:—

- o Extension of the scope of duties of the "data processing" department with a view to include "information systems engineering" whose task it would be to operate related facilities (including telephone installations, duplicating office, printing office, etc.) and, as a special department, to develop relevant problem solutions.
- o Combination of the central departments which are dealing in "information" (libraries, documentation centre, reporting department, information analysis and evaluation—possibly also the standards department, the patent department, central archives, drawing administration offices, etc.) to form a central organizational unit called Information Management with the scope of duties as have just been defined, to organize and operate the information system of the organization.
- o Simultaneous decentralization of data/information processing wherever possible; integration of the remaining central tasks of information systems engineering into the central information management department.

Whatever may be the details for the procedure—there is no arguing: "Data processing" is a part of "information processing", information processing, in turn, is nothing but a tool and thus part of the "information management system".

5.3 The external information system

To satisfy their demand for external information, industrial organizations must be able to have recourse to external information institutes. The task to acquire, prepare, and make available such information by themselves would, in general, be too great a burden even for large industrial enterprises.

Out of mere financial considerations, the supply of external information can be realized only at a national, if not even supra-national, level. Here, too, the standardization of hardware and software for purposes of information systems engineering is not necessarily a prerequisite for smooth information transfer. However, international standardization of terminology which is to be achieved through close co-operation between the information sources, information consumers, and external information institutes is a must and would also help to overcome the language barriers.

The external information institutes must not restrict their information supply to the classical literature. A fundamental change is required to switch from discipline-oriented information to system and problem-oriented information—at least an extension of tasks in this direction is required. Besides, if the external information institutes are to become again of interest to the industrial organizations (this interest is still decreasing), they will have to supply all types of information required in a form which is suited to the user, from the gray literature via the information provided by the mass media, patents and standards including numerical data, as well as information generated at meetings, conferences, etc. Consideration has also to be given to the specialist information for the non-specialist and to the task of condensing information in the meaning of "information analysis centres".

In addition, the external information institutes at the national and supranational levels should perform the same tasks of a systematically pursued information management as the organizational units "information management", as discussed above, for the individual industrial organization. Besides, the existence of such organizational units like: Information Management in industrial organizations is an indispensable prerequisiste for the successful co-operation between industry and external information institutes.

Apart from its internal functions, the Information Management of individual industrial organizations is required as the central liaison and co-operation party for the national, European, and international information institutes which are in the process of creation, and for the authorities responsible for these institutes. It procures the internally required external information from the external information institutes and, in turn, provides these institutes with the internal information of the organization which is of

a more general interest (unless such internal information is confidential or protected by proprietary rights). Furthermore, it co-operates with the external information institutes on a partnership basis in the planning and setting-up of the external information systems, in the interlocking of the internal with the external information systems, and in the elimination of barriers that obstruct information transfer.

Table of Contents

Summary

1. INFORMATION TRANSFER IN INDUSTRIAL ORGANIZATIONS

1.1 Production factor "Information"

1.2 Direct and indirect information transfer

2. INFORMATION REQUIREMENTS AND TECHNOLOGICAL ACTION

2.1 Technology as the motor of progress

2.2 Innovation

2.3 Innovation defined as a system change

2.4 System management and progress

2.5 Conclusions concerning the information requirements

2.6 Meeting the information requirements

3. CHANNELS FOR INFORMATION TRANSFER

3.1 The classical channels

3.2 Non-classical channels for information transfer

4. BARRIERS TO INFORMATION TRANSFER

5. INFORMATION MANAGEMENT

5.1 Information, documentation, and data processing

5.2 Information Management of industrial organization

5.3 The external information system

COMPUTER MECHANISMS FOR INDUSTRY'S INFORMATION TRANSFER

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SUMMARY

Information transfer methods are improving at a rapid rate. Evolving computer technologies are offering a variety of improved ways to transfer and utilize information for industries/organizations. The merging of communication and information/data processing is producing a new competitive environment of integrated technologies permitting improved data, information, voice, and image communications. Computer software is steadily improving along with new, more economical hardware devices. Data base storage and retrieval, teleconferencing, electronic messages, and conversational modeling are developing areas. The purpose of this paper is to review the present status and future trends of these developments.

INTRODUCTION

New computer systems and methodologies that assist industry to organize and transfer information are evolving in a variety of ways. Careful review of the new develements is necessary for an organization when planning its information systems needs. It is becoming increasingly difficult to review and organize information systems in view of the variety of computer mechanisms currently available and emerging in the near future. Popular trends of computerized information transfer mechanisms are reviewed in this paper. Emphasis is placed on online computer systems versus batch systems. Today's systems and techniques are responding to what the user wants and needs. As the use of computerized mechanisms increases, competition and economies of scale will help reduce costs and stimulate continued growth.

COMPUTERIZED DATA BASES

Computerized data bases that logically structure data and information within a specific area of interest are finding many applications in today's industry. Currently, information may be utilized through data bases in three main ways. Online access to many data bases residing at a centrally located commercial organization is one method. Another technique is to purchase data bases and offer them within the organization. A great deal of data is generated within an organization which is transmitted to appropriate individuals when needed. Both commercially available data bases and those developed within an organization are primary methods of storing, managing and retrieving data and information. Distributed data bases is a more recent mechanism that will be discussed later in this paper. The two main types of computerized data bases are bibliographic and numeric.

Bibliographic Data Bases

The world rate of journal literature growth is alarming (Ref.1). For the U.S. alone, from 1960 to 1974, the number of scientific and technical journals increased from 6,335 to 8,460 for a 30 percent growth. Between 1975 and 1980 a further increase of 10 percent is expected. The world rate is higher than that of the U.S. By 1980, the U.S. share of the world journal literature will be only 15 percent.

According to Williams (Ref.2) by the end of 1977 more than 360 bibliographic data bases in computer-readable form were available to the public. The data bases contain over 71 million items. This represents a growth of 36 percent from 1976. Of the 71 million items, 70 percent are available for online searching. More than two million online searches were made in 1977. Today over 90 percent of all scientific and technical articles are available as machine readable and thus available through online search systems. Online access to the literature is swiftly becoming the fastest, most successful way of searching the literature.

Numeric Data Bases

Extensive amounts of numeric data exist, both for private and public access. For the first time the 1977 Annual Review of Information Science and Technology devoted a complete chapter to numeric data bases and systems, Luedke (Ref.3). Improved techniques in managing, retrieving and analyzing data are rendering machine data bases significant resources. Problems are often voiced about the volume of numeric data, its transferability, and accessibility. Numeric data of many varieties are being collected, processed, and disseminated at a mind bending pace. This should continue into the foreseeable future (Ref.4).

Data transferability can be improved in a number of ways; for example, standardization. Organizations, such as the Committee on Data For Science and Technology (CODATA), are doing their part in fostering data exchange through improved definitions of data, using such concepts as data tagging and flagging. Another approach to improving our ability to transfer data is to devise better and more flexible systems for handling and accessing the data. Over the last several years we have witnessed great strides in accessibility to bibliographic data bases. While the problems for numeric data bases are somewhat different and more complicated, there is no reason to believe that similar advances cannot be made with numeric data base systems. Commercial services are now available for accessing both bibliographic and numeric data.

Commercial Services

Commercial services for online access to bibliographic and numeric data are being utilized by many organizations. Lockheed, Systems Development Corporation (SDC) and Bibliographic Retrieval Services (BRS) using the DIALOG, ORBIT, and STAIRS online systems respectively offer approximately 100 bibliographic data bases in total. These U.S. based services have developed user-oriented text searching languages which are readily accepted by the users. All three services use IBM computers. International access is possible via TYMNET and TELENET communication networks. By the end of 1978 Info-Line, Ltd., a European based organization, will be offering a similar service on a UNIVAC computer using the BASIS system. Commercial services for textual files using batch or online access exist in special subject areas. An example is the legal field where the ASPEN, LEXIS, and WESTLAW computerized data bases contain millions of U.S. statutes and decisions.

Minimal numeric data are available in the previously mentioned bibliographic data bases; however, for more extensive numeric data bases other services can be used. Lockheed offers the Predicast numeric data base in the form of time series data for industrial, social and economic data. An extensive amount of numeric data is available through other online services including scientific and technical, social, economic, and financial. Computer timeshared network services such as CYBERNET, G.E. Information Services, and Tymshare offer many numeric data bases. Data Resources Inc. (DRI) is a popular online data base for U.S. economic data. Many organizations use the DRI data bases and modeling capabilities to assist in planning for the future.

TECHNOTEC is a new data base concept offered by the Control Data Corporation for organizations to load information describing their new technologies. The data base is accessible over the CYBERNET network. Those interested in a certain technology, capability or expertise can inquire for their needs through the TECHNOTEC data base online.

Organizational needs cannot always be met through commercial data bases; therefore, in-house data bases are often necessary.

In-House Data Bases

Many organizations are creating in-house data bases. Textual information or numeric data may be obtained from other organizations or generated internally. The U.S. government is a large supplier of information and data. Chemical Abstract Services, INSPEC, and similar organizations sell digitized data bases. Access to these in-house data bases may be through specially developed software; although the trend is for companies to acquire existing proven software. Some existing software for online information storage and retrieval includes: BASIS, INQUIRE, ORBIT, RECON, and STAIRS.

Typical costs to purchase an information storage and retrieval (IS&R) software package ranges from $30,000 to $80,000. Systems tailored for special areas, such as the legal field, also are available. CDC Litigation Services licenses a batch and online system called PALLAS which operates on a number of medium size computers. An organization can load its legal file onto Control Data Corporation's CYBERNET computers using PALLAS or load the file in-house using PALLAS on one of several different size computers.

Numeric data can be handled inside an organization through special applications programs or through a data base management system (DBMS). Over the last 10 years, more than 20 heavily used DBMS have been developed and are offered by vendors. In a recent Computer World article, Ross (Ref.5) describes 22 of these DBMS. Some of the more popular DBMS offered by independent vendors are TOTAL, IDMS, ADABAS, and SYSTEM 2000, all of which permit online access. Several thousand DBMS applications have been made over the last several years at a cost of $30,000 to over $140,000 per initial installation. There is neither a universally accepted definition of a DBMS nor a standardized set of characteristics which define a DBMS. In general, a DBMS should have the following characteristics (Ref.6):

- Build index files or data bases
- Perform logical sequential or direct access processing based on keyword values
- Retrieve records in several ways
- Perform Boolean searches
- Perform searches called from compiler-level application programs such as FORTRAN or COBOL
- Generate reports.

The use of a DBMS data base by a nonprogrammer is possible; however, programmers usually access the data base for others. The text handling capabilities of most DBMS are restrictive. In general the DBMS are slowly gaining additional text handling capabilities and attaining better query capabilities. The IS&R systems, like BASIS and INQUIRE, are also obtaining better DBMS capabilities. INQUIRE was originally developed for IS&R uses but lately has attained DBMS capabilities. Most of the IS&R systems and DBMS have been implemented on only one type of computer. The DBMS System 2000 has been implemented on 3 computer types. All the IS&R packages mentioned before are implemented on IBM computers. The only IS&R system operational on several types of computers is BASIS. BASIS is operational on six different computer types. This is accomplished by programming BASIS in a higher level language, FORTRAN, and by using a translator to obtain the machine dependent FORTRAN for a particular machine.

Distributed Data Bases

There is growing interest in the concept of distributed data bases where there is decentralized access to decentralized data bases. Distributed data bases may be viewed as connecting remote data bases. Data of interest to several groups may be transferred to a centralized file. Often individuals and groups want their own computer and data base, the distributed concept allows this. Distributed data bases permit appropriate access and security of the data. Freedom to manage and utilize the data by the organization in control is also characteristic of a distributed data base. Control of costs can also be improved. However, if the organization does not have standards and minimal centralized control, consistency between distributed data bases may degrade. Many distributed data base users desire to pass data between data bases. This desire cannot be met without sufficient standards or centralized control.

There is a great deal of apparent interest in the use of IS&R systems and DBMS on mini computers. A major reason for this interest is to enable use of distributed data bases. ADABAS, BASIS, IDMS, and TOTAL are either operational on mini computers or should be soon. The costs for these mini based systems range from $20,000 to over $60,000 depending on the desired capabilities. Data bases are a key resource of data for an organization's information and modeling systems.

MODELING SYSTEMS

Many companies are developing computer based management information systems (MIS) to control their current operations and plan for the future. A company may utilize IS&R systems and DBMS to incorporate both internal/external information and data in their MIS. There is also a need to utilize an MIS for investigating certain company situations and forecasting future trends. A definite trend is developing for middle level management to utilize computer modeling systems to help accomplish their company's forecasting. Naylor (Ref.7) identified over 2000 corporations in the United States, Canada, and Europe that are either using, developing, or planning to develop some form of corporate planning models. However, Naylor does not differentiate between batch and real time systems. The number of corporations using models in 1976 represents a tremendous increase from less than 100 corporations in 1969. Over 50 percent of the modeling was prepared with programs written in FORTRAN and most of these were used for a batch processing model. No other language has a percentage of use greater than eight percent. However, online conversational modeling languages are showing a rapid increase in use.

There are approximately 60 conversational modeling languages, such as DYNAMO, NUCLEUS, and SIMPLAN. Nearly 60 percent of the firms that support models also subscribe to national econometric data services: Data Resources, Inc., (DRI), Chase Econometric Associates, Inc., or Wharton Econometric Forecasting Associates, Inc. Companies subscribing to one of these services utilize online, real time access to up-to-date business statistics covering many aspects of the U.S. economy. Large econometric models of the U.S. economy are used in a variety of ways to project growth in specific sectors of the economy. Output from these services can be used as input to a company's corporate model portion of their MIS. Many companies supplying these real time modeling services have a current annual sales growth rate of 20 to 30 percent in the modeling area.

TELECONFERENCING (COMPUTER CONFERENCES)

Individuals geographically dispersed can exchange information and ideas over a communications network to facilitate group communications (Ref.8). This can be accomplished within one geographically dispersed organization or at different organizations. A computer conferencing system provides hardware and software to store comments and provides rules and responsibilities for the participants. The outline of the conference, along with a series of comments on a topic, is stored in the computer. Participants may review and enter their own comments. Any participant may make entries, which can be directed to one or more participants. Each participant can review and contribute to the system at his own chosen times, reviewing what had happened since his last usage.

Satellite Business Systems (SBS), a new U.S. domestic carrier owned by COMSAT, IBM and Aetna, plans to offer a teleconferencing capability to large companies as one of its main services when SBS begins providing services in 1981 (Ref.9). In interviewing some of the U.S. FORTUNE 500 companies, SBS believes teleconferencing will replace some of the travel now necessary to hold meetings and will improve the overall information transfer between remote groups. The New Jersey Institute of Technology, with National Science Foundation (NSF) support, is studying the impact of computerized conferencing upon scientific research communities. The National Telecommunications and Information Administration (NTIA) is planning to sponsor a teleconferencing project among 55 NASA centers and contractor plants. Positive results from these studies should stimulate increased industry interest in teleconferencing.

ELECTRONIC MAIL

Many organizations have the need to communicate and use high-priority information. Such information is now being handled by conventional means: special delivery mail, courier, electronic communication on a point-to-point basis, e.g., facsimile. These methods are costly, time consuming, and labor intensive. There are specific limitations to changing these methods to reduce cost and improve delivery time. A promising alternative is electronic mail.

Electronic mail is the generation, transmission, storage, disposition, and display of business correspondence and documentation by purely electronic means instead of by normal paper processing and document distribution means. Hardcopy is printed only if required. Electronic mail offers a corporation or other large institution a superior, automated alternative for its inter- and intra-organizational paper communications flow. As communication capabilities are added to word processing, electronic mail will be interfaced to office systems (Ref.10). Today less than 15 percent of installed word processing systems have communications, but a true communications environment for this type of system is just beginning.

Two existing electronic mail systems are Scientific Time Sharing Corporation's "Mailbox" and Computer Corporation of America's "COMET". COMET was announced in March 1978 as a mini computer based electronic mail system. Several industrial organizations are using COMET to compose, edit, send, receive, file and retrieve intra-company correspondence.

In the Washington, D.C. area, Digital Broadcasting Company has recently offered an inexpensive communications network able to deliver letter-type messages via FM radio (Ref.10). Its first customer, Giant Foods, a supermarket chain, plans to service 10 cities within one year. Local telephone loops and TELENET circuits are used to get the user's message from a terminal to the central computer; then the message travels to a commercial FM station for broadcast. Receiving terminals decode and print the messages at the recipient's end. The company states this type of service costs five cents for a 300-word page message transmitted on a broadcast basis. Station-to-station transmission is 15 cents a page.

SBS has also looked at the potential for electronic mail for large U.S. companies and believes this to be an excellent market for their new carrier. In most companies interviewed, 50 percent of all mail was intercompany, 40 percent was intra-company, and 10 percent was other.

The future of electronic mail depends not only on inexpensive terminals and low-cost telecommunications but also on secretaries, managers, and other users being willing to adapt themselves to the new methodology.

VOICE RECOGNITION

Voice recognition is defined as the ability of a person to speak into a microphone connected to a computer and to be "understood" by the computer system. Several voice recognition commercial systems which are on the market today can be used for only a limited vocabulary. Interstate Electronics Corporation and Threshold Technology are companies with commercial systems that not only require a pause between each word but also each user must train the system for his individual use by speaking each word. The vocabularies are restricted to less than 1000 words. No equipment is currently available that will recognize continuous speech; however, Nippon Electric has released brochures indicating they will market a product in 1978 which recognizes continuous speech. This appears to be a step closer to a practical voice recognition system.

Voice recognition systems of the future should permit users of online information retrieval systems to make queries with very little or no terminal keying. This simplification is expected to result in a greater number of people using these systems.

CONCLUSIONS

Computerized systems which organize and transfer industry's information have made tremendous advances in the 1970's. The greatest accomplishment has been the development of data base technology, including remote online access. The growth in use of online bibliographic data bases should be followed by a strong growth in online numeric data bases. Proven IS&R systems and DBMS are fostering thousands of data bases, developed by commercial services and in-house. Distributed data bases utilizing mini computers appears to be a strong growth area for the future. Modeling systems are enabling large organizations to incorporate internal/external information and data for company planning and forecasting. Data bases are an important source of information and data for these models. Improved telecommunications along with improved hardware and software are opening up the new and exciting areas of teleconferencing and electronic mail. Currently, individuals must type or key in requests on computer terminals to utilize many of the systems and techniques. Future advances in voice recognition systems should minimize this keying and result in increased usage through human/computer voice communications. The coming decade is certain to result in additional new and exciting computerized mechanisms for information transfer and utilization.

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TECHNOLOGY TRANSFER FOR MANUFACTURING INDUSTRIES

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The paper is based on experience of about 100,000 technology transfer projects spread over 5,000 factories in 30 countries. Availability of so many case histories of technology transfer covering a wide range of manufacturing industries has made it possible to predict with reasonable certainty the types of technology which factories can best utilise, the time and cost of effecting technology transfer, the likely influence of human psychological factors in impeding technology transfer, and the influence of other factors such as the history of the plant and the industry concerned, incentives and disincentives for both workers and management, etc. Technology transfer must extend right through to the point of implementation. The essential requirement is motivation of management and workers otherwise the end result of technology transfer is failure. The progression of improved manufacturing techniques from the initial stage of scientific possibility to the final stage of extensive profitable application in industry is studied. Examples are given and the cause of failure is identified as a HIP barrier composed of factors associated with (i) History, (ii) Incentives, (iii) Psychology. The nine stages of penetrating the HIP barrier are discussed.

The most effective means of disseminating technological information in industry varies according to the type of information involved, and the objective of dissemination. This paper is confined to technological information related to manufacturing activities where the objective of dissemination is improved productivity. The physical manifestations of improved productivity may take many forms such as improved factory output, improved product quality, improved material utilisation, etc., but the ultimate yardstick by which improvements in productivity are usually measured is economic gain, i.e., cost effectiveness and profitability. Thus the objective of disseminating the results of production research is the economic gain achieved by implementing those results in factories. Recognition of this objective enables dissemination and implementation - now frequently referred to as technology transfer - to be seen as part of a chain of events in which time and money are of very great importance. This chain extends from the production problems and opportunities for productivity improvement in a given factory or industry through to the successful application of the new technology and the realisation of worthwhile economic gains.

In the highly competitive environment of the manufacturing industries any central organisation responsible for technology transfer must aim to help each factory attain maximum economic gain as quickly as possible, and yet keep to a minimum the total cost of providing technology transfer in thousands of factories. In the case of PERA this has involved over 100,000 technology transfer projects spread over about 5,000 factories in 30 countries. For our own convenience we call each complete technology transfer project a "Prodaid". Some Prodaids may be small, such as those concerned with cutting tool angles, whereas others may be large such as those involved in changing a complete factory to a system of group technology.

One advantage of having so many case histories of technology transfer covering a wide range of manufacturing industry is that it has enabled us to study not only the technological aspects of technology transfer, but also the economic and human aspects. It has enabled us to predict with reasonable certainty the types of technology which factories can best utilise, the time and cost of effecting technology transfer, the likely influence of human psychological factors in impeding technology transfer, and the influence of other factors such as the history of the plant and the industry concerned, incentives and disincentives for both workers and management, etc.

On the basis of experience over a long period we know that if technology transfer is to justify itself by bringing real economic benefits to individual factories in the manufacturing industries it must extend right through to the point of implementation. In practice this means that merely making industry aware of research results is not very effective unless it is followed by advice and assistance in adapting the research results to suit the individual factories concerned.

The essential requirement is to motivate management and workers to make the necessary changes, otherwise the end result of technology transfer is failure. Although the advice may be free in monetary terms nevertheless there is usually a substantial "selling" job to be done. The high level of confidence necessary before managements will risk <u>their</u> money and <u>their</u> reputation in making changes to improve productivity can

be engendered only if the advice is tailor-made and is seen to be tailor-made to suit the exact circumstances and resources available in that factory at that particular time. Without this kind of individual attention the percentage of factories actually changing to improved methods of manufacture, and therefore the cost effectiveness of any large scale technology transfer scheme can be lamentably low. An individual service for each factory is essential for large scale success.

The relationship between the technology and economy of change and other factors affecting technology transfer in the manufacturing industries is illustrated in Fig.1. This shows the progression of manufacturing techniques from the initial stage of scientific possibility to the final stage of extensive profitable application in industry.

The illustration shows that basic scientific knowledge (1) passes through an applied research and development processor (A) which includes activities of research and development in industry, research stations, etc. As a result some of the basic knowledge becomes transformed into technologically possible techniques usable in industrial practice (2), but the fact that these techniques are technologically possible in a particular factory does not necessarily mean they should be applied there. The economic consequence of implementation must first be examined and this is done through an economic filter (B). Thus, the techniques which are both technologically possible and economically desirable in a given situation are identified (3). These are the techniques which ideally should be applied extensively throughout the factories in which they are applicable. In fact, the application of these techniques in industry at large is far from complete, and the losses shown in the diagram can be attributed to a barrier (C) composed of factors which fall into three groups associated with (i) History, (ii) Incentives, and (iii) Psychology - consequently we call this the HIP barrier.

The history element of the barrier includes not only the history of the individual persons concerned with the change, but also the history of the company, the industry and the country. Consciously or unconsciously individuals, companies and industries are greatly affected by their history and this can often give rise to built-in attitudes affecting change, particularly speed of change. The result may be considerable inertia which reduces the speed of change to improved manufacturing techniques and higher productivity. Similarly at national level sometimes another country suddenly leaps ahead because it is not constrained by the same historical influences. If we can clear the decks and start forward without the encumbrance of history and maybe tradition, we can progress much faster through the changes necessary to achieve effective technology transfer.

Incentive is the second element in the HIP barrier. Once we are freed from the ties of history which restrain us in making progress, the individual or company or industry requires a force to move it forward. As a physical analogy this force will be a "Push" or a "Pull". One might regard the "Push" as forcing an issue, and this in the end is too costly and inefficient in modern factories. One might regard the "Pull" as a pull of attraction arising from persuasion, and the first element to be considered in persuasion is incentive. Thus, having been freed so to speak from the chains of history, what incentive is there for the free body to move forward, i.e., for the new technology to become part of the factory activities?

Obviously, if the incentive is exceptionally large then the change to more advanced methods of manufacture will be made very quickly, but it is not economically possible for the whole of the manufacturing industries to be given exceptionally large incentives. Consequently, in practice we are faced with the problem of how to establish a worthwhile incentive without involving intolerable expenditure. The main incentive is money, and although others are relevant in particular circumstances, their influence is usually secondary to that of money. Moreover, to some extent money is the means of satisfying these other incentives including basic needs such as survival, status, stimulation and security.

The survival incentive in industrial societies is now largely overlaid by a standard of living incentive based on the level of expectation which sets the dividing line between what are regarded as necessities and what are regarded as luxuries. Some of today's necessities in industrially advanced nations are still luxuries in less developed nations, but the level of expectation is continually rising. A rapid growth in productivity can be sustained indefinitely only if incentives are re-considered continually in the light of individuals' constantly changing needs and expectations. Various other factors also influence industrial productivity, and in certain countries religious beliefs, for example, may modify attitudes to work and therefore to incentives. However, in the absence of such factors, material incentives and the desire for a continuous improvement in living standards normally exert the greatest influence on industrial efficiency. Frequently the positive incentive, money, is reduced by the disincentive, taxation, and as large scale tax reductions are unlikely it is vitally important to remove every other conceivable disincentive.

Psychology is the third element in the HIP barrier and again consideration should be given to all facets of psychology in relation to individuals, companies and industry as a whole. There are many examples of progress to better production methods being blocked for many years on purely psychological grounds; for example, the Production Manager who will not agree to a change suggested by some outside adviser

because he regards it as a reflection on his own ability or authority. Many barriers to progress can be traced back to ordinary human psychological attributes such as fear, conceit, etc., in individuals and groups.

Another aspect of the psychological barrier is the failure to recognise that although money is the major incentive, work is a social necessity and should as far as possible satisfy workers' needs for association with an acceptance by others in a common endeavour, and the need for self-respect and self-realisation in the achievement of worthwhile objectives however commonplace they may be. The trends toward "Job enrichment" and "Job enlargement" in attempts to improve job satisfaction spring from these needs, and developments such as "group technology" provide part of the answer. These satisfactions are an important factor in "motivation" and can thus contribute much to good labour relations.

The HIP barrier is not a simple structure involving in effect three barriers side by side, but rather a barrier in which the three elements recur and interact with each other as in a laminated or reinforced structure. An impression of this is given in (C) Fig.1. The practical effect of this interaction is very significant in many productivity improvement situations. For example, although history cannot in fact be changed, the interpretation of history can vary from one person or group of persons to another, and can thus interact with psychological attitudes and profoundly influence acceptance of change and the speed of change. Different interpretations of history between managements and factory workers have frequently interacted with psychology to produce increasingly irreconcilable divergence of objectives. A much fuller understanding of these interactions of the elements within the HIP barrier is necessary if we are to penetrate it efficiently and reduce the losses it incurs. Only then will technology transfer make its full contribution to wealth production in the manufacturing industries.

Unfortunately by its very nature the HIP barrier cannot be removed completely for all time. The resistance to change offered by two parts of its triple structure, namely, "history" and "psychology" cannot together be disposed of by the variations of "incentive" which are available within the limits of industrial or even government resources. History cannot be altered, and our ability to alter human attitudes is severely limited. We are therefore forced to seek alternative means of reducing the heavy losses caused by the barrier, losses which total hundreds of millions of pounds per annum in the UK engineering and allied industries alone due to years of delay in adopting improved manufacturing techniques.

The PERA approach is to make numerous penetrations of the barrier which, though small are permanent and can frequently be enlarged. Depending on the nature of the new technology, the factory environment in which it is to be used, the ability and attitude of the recipients, etc., the form, duration and cost of technology transfer can vary enormously. A breakdown of the technology transfer process between a research station and a factory includes nine stages.

1. Acquaintance — First exposure to information about the technique
2. Assimilation — Study of general information about the technique, including costs
3. Adaptation — Relating the technique to the specific needs of the company
4. Assessment (Preliminary) — Detailed evaluation of prospective benefits
5. Application (Pilot) — Trial application of technique
6. Assessment — Evaluation of advantages and disadvantages after pilot application
7. Adjustment — Modification in light of pilot experience
8. Application — Full application
9. Accounts — Audited accounts to verify economic gain

Thus, the new technology is applied resulting in more efficient manufacture and the opportunity of more competitive marketing and improved profits. Although the technology transferred may come from research initiated by the factory or industry concerned, it may also come from research elsewhere or from developments in other factories - sometimes referred to as cross-fertilisation. The relationship of technology transfer to the sources from which new technology is derived and to the industry to which it is transferred are shown diagrammatically in Fig.2.

Experience shows that resources available for transferring new technology to factories should mainly be concentrated on securing specific changes in specific factories. Successful implementation and economic gain in 5,000 factories is far

better than ineffective technology transfer in 50,000. A desirable discipline for those concerned with technology transfer is to measure their own economic efficiency by taking reasonably large representative samples of the results achieved and by comparing authenticated assessments of the economic gains in these factories with the technology transfer expenditure involved. This gives a "Response Ratio" defined as the net economic gain divided by the technology transfer expenditure. In a sample of 100 technology transfer projects the average Response Ratio was 46 to 1. Eight examples are briefly summarised in Fig.3.

The foregoing comments on technology transfer for the manufacturing industries show that effective dissemination and implementation of research results is a difficult operation which involves considerable expenditure and demands high levels of skill and experience. In the past in many countries the task has been under-estimated, the effort inadequate, and the results very poor. It is true there are some research activities where the effort and expenditure are justified by simple publication of the results, or by sending the research reports to potential users and leaving them to get on with it, or by using the results merely as a measure of success in a teaching exercise, but an increasing amount of research expenditure today is fully justified only if it makes a direct contribution to the effectiveness of our wealth producing industries. To achieve this the dissemination of research results must lead to action in industry. The physical and financial consequences of that action should be measured and thus technology transfer will not only ensure that the ultimate objective of these researches is achieved, but will also provide a feed-back of information which will vastly improve our procedures for future selection of research projects, and implementation of research results.

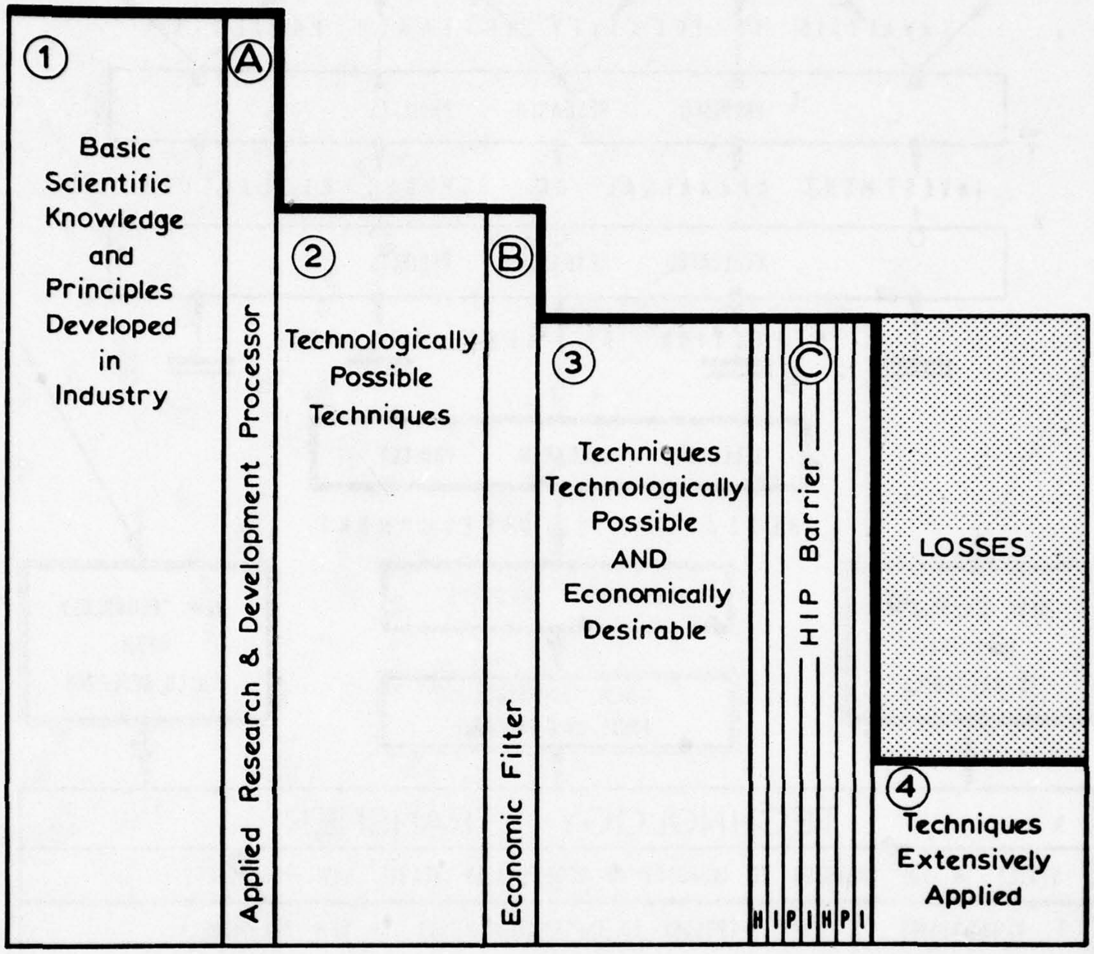
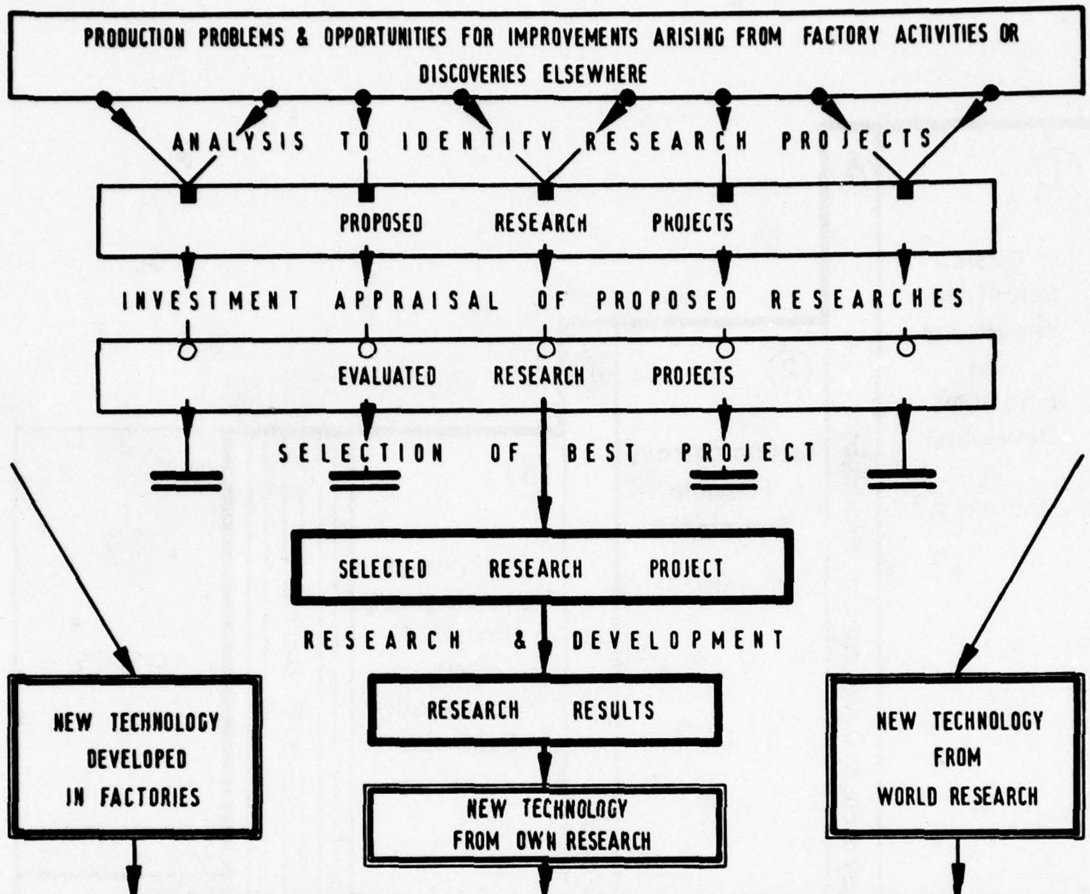


Fig. 1. Technology Transfer & HIP Barrier Losses



TECHNOLOGY TRANSFER

STAGES IN THE TRANSFER TO INDUSTRY OF ECONOMICALLY VIABLE NEW TECHNOLOGY		
1	ACQUAINTANCE	FIRST EXPOSURE TO INFORMATION ABOUT THE NEW TECHNIQUE
2	ASSIMILATION	STUDY OF GENERAL INFORMATION ABOUT TECHNIQUE, INCLUDING COSTS
3	ADAPTATION	RELATING THE TECHNIQUE TO THE SPECIFIC NEEDS OF THE COMPANY
4	ASSESSMENT (PRELIMINARY)	DETAILED EVALUATION OF PROSPECTIVE BENEFITS
5	APPLICATION (PILOT)	TRIAL APPLICATION OF TECHNIQUE
6	ASSESSMENT	EVALUATION OF ADVANTAGES & DISADVANTAGES AFTER PILOT APPLICATION
7	ADJUSTMENT	MODIFICATIONS IN LIGHT OF PILOT EXPERIENCE
8	APPLICATION	FULL APPLICATION
9	ACCOUNTS	AUDITED ACCOUNTS TO VERIFY ECONOMIC GAIN

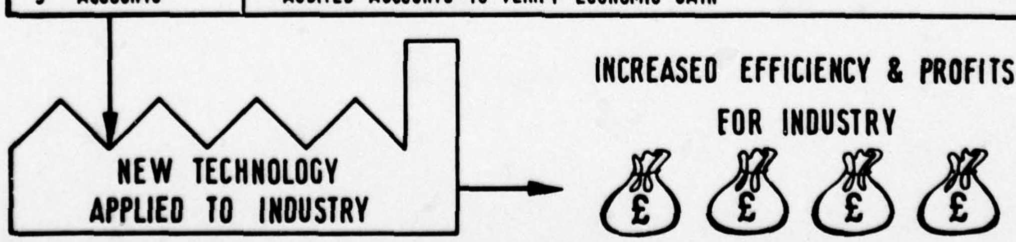


Fig. 2. Technology Transfer to Improve Manufacturing Efficiency

FIG. 3 - EXAMPLES OF TECHNOLOGY TRANSFER

	OBJECTIVE	ACTION	RESULTS
1.	To reduce cost of producing domestic utensils.	Improved manufacturing techniques, particularly finishing processes.	Saving £7, 000 p. a.
2.	To reduce cost of producing complex metal containers.	Introduction of cold extrusion to replace other techniques.	Saving £30, 000 p. a.
3.	To increase exports of wire manufacturing machinery.	Replaced metal structures by carbon fibre reinforced plastics.	Speed and output of machines increased 4 times, hence increased sales.
4.	To increase output of components for agricultural equipment.	Rolling operations substituted for conventional techniques.	Output increased from 4, 200 to 10, 000 per week.
5.	To reduce machining costs on small batches of medium sized engineering products.	Introduction of Programme Sequence Control to existing machines.	Savings £12, 000 p. a. and reduction in labour, scrap and floor space.
6.	To reduce cost of pump production and eliminate corrosion.	Aluminium castings replaced by precision glass fibre reinforced plastic mouldings.	Component costs reduced to half. Corrosion eliminated.
7.	To raise output and reduce scrap in manufacture of glass-ware.	Application of high-speed pneumatic indexing system to glass-pressing machine.	Output increased 30% and scrap reduced 60% saving £12, 000 p. a.
8.	To reduce cost of manufacturing solenoid cases.	Introduction of cold extrusion techniques.	Costs reduced 45% and floor-space requirements reduced.

REVIEW OF SELECTED INFORMATION TRANSFER STUDIES

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SUMMARY

Factors which influence the transfer of information in research and development are examined under three separate headings, the individual, the group and the organisation. A wide range of sources is drawn upon to argue that the individual is the most important influence on the way in which information is used but that the organisation can influence this in a variety of ways.

The conclusions drawn are that the effectiveness of information transfer can be increased by examining the barriers to communication, and it is argued that some of these can be reduced, if not entirely eliminated, by focussing attention on areas such as recruitment, rewards systems, and team development as well as on geographical and organisational factors.

In looking at the management issues raised by some of the literature on information transfer it is important to recognise that research and development is not a homogeneous activity. Its character can vary between different parts of the same organisation as well as across organisations. Its purpose can also vary and this is something which needs careful and specific examination before one starts to talk about mechanisms and management actions which might improve the effectiveness and contribution which R and D can make to the organisation. A point to emphasise is that differences will be identified between,for example, research and development, between long and short term activity, between basic, fundamental and applied, etc. - although it is clear that problems of definition make distinctions between many of these categories rather blurred.

It is also important to remember that R and D is rarely done for its own sake. The output is most likely to be information and it is the use to which this is put that determines the value of the work. Management must therefore be concerned with

a) information transfer of a scientific and technical nature which will affect the quality of the work and

b) information transfer between R and D and other functional areas, users etc. in a two-way set of transactions to ensure that problems and needs are adequately defined and results are effectively applied.

In looking at these two different aspects of information transfer one is conscious of the fact that there is no shortage of research materials on which to draw. And it is perhaps comforting that most of the findings fit well with the personal experiences of many successful and notable contributors to the innovation process. In particular the evidence is fairly conclusive that technical excellence is an important, even vital, contributor to success. Without this it is very difficult for an individual,group or organisation to remain in the forefront in a scientific or a competitive sense. Although such excellence is a necessary condition for successful R and D it is not a sufficient one. There is considerable evidence that other factors often of a managerial nature can reduce the value to be obtained from even the best scientific and technical effort. An examination of the literature in this area reveals that many of the problems arise here because of ineffective communication and information transfer, and that some steps can be taken to change this situation to the advantage of all parties. In order to examine some of the key issues a brief introduction is provided to some of the literature on the subject, and some conclusions are drawn about management actions which will increase the contribution of R and D to the organisation of which it forms a part.

However, relevant work has been undertaken in many different fields and for many reasons. In order to draw this together in a meaningful way which will bring out some important management implications, it is proposed to look at it under three headings - the individual, the group, and the organisation. Starting with our knowledge of the positive aspects of information transfer, we will look at ways of increasing these and reducing some of the barriers or constraints.

The approach must necessarily be progressive in that arguments relevant to the individual carry over to the group and from both of these to the organisation.

The Individual

The individual is a source of ideas, a colleague, a member of a team. Every individual's contribution is important, albeit in different ways. Research shows that some people communicate a lot, some very little. High communicators tend to be high performers (i.e. as individuals) and also high contributors to a team. Some people make use of many information sources, personal, literature, etc. and draw on sources outside their own specialty, as well as outside their own organisation. Such people

have been referred to as 'gatekeepers'. They have an important part to play in research and development. In addition there is considerable evidence to show that innovation frequently comes about through new ideas, new insights being brought into the organisation from outside. The literature clearly shows that this can occur by people joining the organisation or the team and bringing with them personal experience from a different environment. There is also considerable evidence that the encouragement of 'free' thinking, and the use of outside and often unusual stimuli can produce new approaches to problems and many organisations are now encouraging the use of creative problem solving approaches to bring in new ideas. Finally, we know that some people are always open to fresh inputs and see unusual and exciting possibilities in many different directions.

The evidence, then, is that some individuals are very willing to accept information, to share their ideas with others, to be perceptive, and often to put 2 and 2 together and make five. We also know that other people do not appear to have, or at least don't often show these characteristics. Some research suggests that this could be due to personal psychological characteristics. More creative people, for example, are said to be able to stand being wrong more than others - they don't worry as much about being seen to have ideas which at the time might be assessed by others as irrelevant or even stupid. They are often higher risk takers and in R and D we must be willing to take risks. Any organisation which undertakes a post-audit of its activities is almost certain to find that a significant proportion of these are not successes in the sense that they are taken through to the exploitation stage. The more we get away from the pressures of timescales and very tightly defined programmes we would hope to see the opportunity for people to put forward and to pursue new and perhaps way-out ideas. In R and D we must be willing to allow, indeed positively encourage, people to look outside themselves without fear of such actions being seen as failure in others' eyes. It is not surprising, then, that our so-called 'gatekeepers' are more often than not the best performers, that managers who ask the most searching and yet often perhaps the most obvious questions, are the best managers. Success breeds success. People who have proved their ability can afford to show their ignorance in many areas, providing of course they are willing to listen and to probe deeply into the answers - because the respondent himself may well have good reasons to want to be secretive, to perhaps try to show his superior knowledge in his replies. Why should this be so? Is it because knowledge can bring power? Or are some people reluctant to provide others with answers to their problems, because they feel their contribution is not going to be rewarded? Or do they perhaps think the person concerned should himself be knowledgeable in the area and is in fact paid to be so? Who does what and how people are rewarded can have a significant effect on the willingness of people to transfer information.

This is where we can have real problems in R and D. Many projects are essentially team efforts and yet it is clear that all members of a team are not equally rewarded. At the extreme some may feel that their contribution could be the most significant but would be the least rewarded. In such cases they may wish to keep it to themselves to be revealed only in the presence of people who can influence their progress or, and possibly even worse, when the project has got into real difficulties from which it has to be rescued. A point to be drawn from this is that in some cases the individual is less committed to the success of the project than to his own showing with the extreme situation occasionally occurring when the individual could be more committed to the failure of the project. In such circumstances he may well act in such a way as to positively withhold information, or distort its possible significance by the method of presentation. This is something which every group leader and organisation has to recognise.

There are many issues which could be raised under the heading of information and rewards and some can be very difficult to handle. For example, we know that there are many situations in which the 'not invented here' (N.I.H.) syndrome is so prominent that the only way to get things progressed is to let other people believe that any useful ideas are their own. How can we, and do we, reward those people who often provide the greatest stimulation and introduce so many new ideas and information inputs into R and D and yet so rarely are involved in progressing them further or bringing them to fruition? Dare we ask at this meeting how for example, the new patent legislation in the U.K. will affect this? How has it affected R and D in other countries? Will it make people more secretive, make communication more formal? Will it have a positive effect through offering the possibility of more direct rewards to the innovating individual? Unfortunately we do not have very much evidence on this subject but it is one which is of concern, and rightly so, to anybody involved in the area of communication and information transfer.

An important point to recognise therefore, is that people, as individuals, must be encouraged to communicate, to look outside for information, and be motivated to provide information to others. There must be a willingness to communicate, and a willingness to spend time listening to other people. Most research shows that although mechanical information systems can be of help to people in R and D, a large part of the information used on a day-to-day basis is passed on by people. It has been argued that the person-to-person contact is vital because very few problems can be so specifically defined and explained that relevant information can be accessed. The problem is only really identified and potential solutions raised through a dialogue which cannot be conducted through a system consisting entirely of hardware. Obviously, with recent developments in information processing systems this is a point for debate, but it is important to note that information does have a timeliness, and that the same stimuli at different time periods can have quite different impacts. People and systems both have memories. Certain people see relationships in a broader or perhaps different way than machines and as such will react differently to contact with others seeking information. A combination of the two may provide the most useful outputs.

Personal experience also shows that similar people confronted with the same piece of information at the same time can see it in very different lights, and that the same person given the same piece of information at different periods of time, sometimes close together, can see its relevance in very different ways. The question of storage and retrieval of information, the ability to recall, must differ by individuals, and there is a good case to be made for a wider use of mechanical information retrieval systems by individuals at more frequent intervals, i.e. not just at the outset of a project or when specific problems arise, but during its progression. Such an approach could not only throw up the same information which might be viewed in a different light but also throw up more recent information which will influence future directions.

On this point is is also important to recognise that much of R and D is not put to effective use because due consideration has not been given to the external environment in which it will be used, and in particular to the changes which can and do occur in this environment during the course of particular projects. This is a point which will be touched on later, but under this section it is important to note that an individual can often be reluctant, even unwilling, to take a look outside in case changes have occurred which will affect his idea or project. As individuals we are not always honest with ourselves and will close our eyes to many things which in our hearts we know are important. A failing which is not only confined to our scientific work but which is also present too often in areas such as personal appraisals.

The Team or Group

Much of what has been said in the previous section could be repeated here. As a team we don't always share all the information we have with each other, we don't always help each other as we might, we don't draw on our colleagues' strengths or take account of their weaknesses and help them to develop to mutual benefit. As much of the creative problem solving literature shows we don't often listen to other people, and we can be more concerned with being negative than positive, with forcing our own ideas through rather than encouraging and building on those of our colleagues.

A point to note here is that these issues have become much more important recently as the amount of multi-disciplinary work has increased involving, as it frequently does, the drawing together of people from different specialty areas. In general team members owe their primary allegiance to their specialist or discipline heads who are the people with responsibility for allocating rewards. In many organisations the discipline head, not the project leader, decides which individuals will be allocated from his section to the project. As such people may well be working on more than one activity at a time a project leader has no guarantee that his team members have a high degree of commitment to his project. In such cases there is certainly no guarantee that team members will want to help each other and be willing to spend the time on discussing and exchanging information about the problems which arise. On this point the literature is clear, a project leader will very rarely get commitment from his team through the use of authority associated with his formal position. He can, however, get commitment if his authority is earned, that is if he is accepted as the right person for the position, whose past reputation and current performance is judged by his colleagues to be of a high standard. This is a good case of the informal structure carrying more weight than the formal, an important point to recognise for organisations who have introduced more flexible structures in an attempt to better manage multidisciplinary projects. An additional point to make here is that a prime determinant of the commitment which people give to a project is the degree to which the work is seen as challenging, either to their scientific abilities or because of the importance and urgency with which it is seen by the organisation and by their colleagues. Such work invites collaboration and commitment and usually gets priority over other less challenging activities.

Research has also shown that the leaders of more innovative groups are not themselves necessarily more innovative than their colleagues who lead less innovative groups. But they are more supportive, they encourage discussion and they allow creative tensions to develop before bringing the team back to the primary tasks at the appropriate time. Not surprisingly, one finds evidence in the literature that discussion, communication and conflict is more frequently associated with increased performance where there is the time and opportunity, and in many cases even the requirement, to explore many possibilities. Successful group leaders in the research area therefore tend to keep a more open mind to new inputs and communication levels within the team are high, and contact with outside sources of information is actively encouraged at all levels. In such situations there is little room for a hierarchical or authoritarian management style.

In development, the literature suggests the opposite. Communication and information transfer often follow the formal organisational structure, contacts with outside bodies are less frequent, and fewer, more senior, members of the team are involved in such contacts. Time pressures often force the acceptance of a structure in which new inputs are seen as difficult to cope with, perhaps suggesting changes which will be seen as likely to cause concern rather than making management easier. Other experiences suggest we should not accept this distinction in approach too easily. There can be considerable room for new ideas and fresh inputs at many stages in the life of a project. A number of practitioners have specifically used techniques of the creative problem solving type to stimulate new thinking and in so doing they have found that many people, including some from outside the project, can make a significant input to the progress of the work. The value of such approaches is the bringing in of other people who are not so conditioned by history as project team members and also in the way in which the analysis is conducted, drawing heavily on the creative problem solving methodologies. In such an analysis hierarchies and prior norms are not allowed to interfere in the communication process. The use of checklists can help to ensure that people do not forget to ask the question they might not wish to ask, and the use of stimuli words can encourage a wider range of thinking. Inevitably such sessions may only raise questions to which answers need to be provided from further extensive literature search and analysis. The important point is that they allow such questions to be legitimately raised without implying criticism of the team, and they encourage the search for new and relevant information inputs. In this sense they might be used more frequently and not, as is so often the case, when problems have already arisen and the search for solutions is desperate.

It must be remembered however, that the person most likely to be at risk in adopting this approach is the team leader, who may be very wary of asking people from outside his project to assist in case this is seen as a reflection on his leadership. As mentioned in the previous section, psychological cost may be seen to be high both by the leader and by his team. Not perhaps surprising then is the evidence that, although innovative ability does not appear to be correlated with age, it can be inversely related to the age of a team, measured in terms of the length of time the members have worked closely together, possibly in isolation from others. Under such circumstances a group cohesion can develop which can lead to the putting up of barriers to information from outside and once again the 'not invented here' syndrome raises its head. A very coherent team, whatever its age structure, can become very complacent about its knowledge of its own special area and can very easily cease to look for, or even be willing to accept,

any information ideas from outside the group. The good team leader must be aware of this and consider ways of countering it by for example, maintaining an environment in which members are actively encouraged to seek outside information and to develop links with people outside the group. He may also bring in new ideas and information inputs through the introduction of new people ensuring a gradual turnover of personnel within the group. The way in which this might best be done will need some careful consideration. For example it may not be sensible to introduce new people who have been recruited with the same pedigrees as the present incumbents, perhaps from the same University, a practice which some companies have actually done. The aim of the change is to bring in new ideas and to open up new communication channels, not to simply increase the strength of existing ones.

In considering the question of how to open up new information channels we would do well to look at some of the early research into the factors which affect the use of existing channels. This tends to indicate that the most frequently used sources of information are those which are most accessible - for example, in terms of geographical location, the psychological cost of access and personal knowledge and understanding of the individual or source. The first of these will be touched on again in the next section, the second has already been mentioned but the third, which is obviously linked to the first two, must not be ignored.

It is easy to underestimate the way in which a project leader or member of a team can put up barriers by the way in which he responds to questions which are asked in the most open way. The information transfer we promote can be very much influenced by the way in which we interact with other people and there is no doubt that we can modify our behaviour to improve the process. Transactional analysis has a lot to say on this subject and a number of organisations are currently experimenting with it as a means of promoting a better understanding of face to face communications. In the same way that we can improve the information we get from any machine-based system by learning more about how to react with it, so we can with personal communication. The net benefit to be gained is very high when people are positive towards each other and feel willing and capable enough to interact with others outside their group.

A final point here is that exposing a team to new work challenges has been found to overcome the ageing team phenomenon - presumably the fresh area invites, or even makes mandatory, new approaches and encourages a wider look at the external environment for relevant information inputs with less likelihood of psychological cost being seen as a penalty.

The Organisation

Building on the issues raised in the previous sections on information transfer by the individual and within the group one is led immediately to draw from the literature factors relevant to the organisation as a whole. For example, to return to the question of gatekeepers. Most people would accept that such people are not too difficult to recognise within any organisation but should their position be formalised? This has been attempted but there is little evidence on which to assess the positive and negative effects of doing this. Many researchers have argued against formalising the position but they also usually argue that they should be rewarded - a point made in the previous section in the context of information providers in general. The question is how can this best be done? Don't promote your gatekeepers out of the job for which they have shown such aptitude by giving them management responsibility. This is a point which has been made many times but unfortunately the power to reward high performers other than through the normal progression routes is very limited. A number of organisations have introduced some form of dual ladder system but the evidence in practice is that they have only been successful in a very small number of situations. Certainly the ability to adequately reward high performers on the communication and information front must be questioned and most organisations would do well to consider this problem as a matter of priority.

The influence of distance on communication patterns was also emphasised in the early studies - the important point being that people do not appear to communicate with others who are more than a very short distance away. More recent research in different environments has demonstrated that this geographical barrier can be overcome by work structure and highlighted the point that people are more likely to communicate if they have a need to do so. However, this does not quite change the importance of distance as an influence on the more informal, and less directly and immediately relevant, exchange of information. It is not possible to legislate for all the possible communication needs within any organisation and informal as well as formal channels are required. The organisation can develop both by encouraging people to participate in projects even when widely separated geographically - perhaps in different locations, laboratories, or even centres. Moving people from one location to another can also promote a variety of communications which will continue for some time. Large organisations have the opportunity to do all of these things.

In the same way, as discussed earlier, any organisation must be aware of the problems which can arise if they keep teams together for too long. They may need to encourage project leaders to consider making changes in their teams if these do not occur through natural wastage and turnover. At the same time the organisation should give serious consideration to its policies on recruitment, secondment, conference visits, sabbaticals, leave of absence and other possible interchange arrangements with, for example, universities, government establishments and even with other industrial organisations.

More contact between research and development can often be very rewarding. Many organisations in the past have resisted this, with the result that very little transfer of useful information has occurred between the two. Means are now being actively sought for ways of encouraging closer working relationships which would be of mutual benefit. It is accepted that some separation is desirable, but that this should not be total. The concepts of bonds and barriers, integration and differentiation etc. were suggested many years ago with the argument being made that you need to make distinction between activities with different time constraints and motivational characteristics. Suggestions were then made that such dissimilar activities might be better kept apart from the management point of view with coordination being achieved through the introduction of separately identifiable individuals who would perform an integrating function.

Some practitioners have argued against this on the basis that it is a doubtful proposition that one can improve communications and information flow by increasing the number of bodies involved, particularly if those bodies are not very closely involved in the activities of either of the functions they are trying to bring together. An alternative approach is based on the proposition that most people are aware of difficulties of communicating with people in different fields from their own but are not always in a position to overcome the barriers because they are not sufficiently aware of the total context within which they are working. A way to overcome some of these difficulties is to adopt a structure which allows much easier cross fertilisation between individuals, for example, the matrix organisation. However this is not usually sufficient and it is necessary to develop a planning and review system which provides up to date information about the overall problem, the sub problems which must be tackled, in what order and by whom. People who have been concerned with management development exercises in R and D will recognise the similarities of this approach with those used in the team building area. If people don't agree on what the problem is, on the contributions they can make and at what time, then the overall performance is likely to be reduced. This is particularly true in multidisciplinary work, an increasing feature of R and D. In many organisations it is not clear what is required and individual members of teams don't recognise, agree and accept their responsibilities. In addition people do not always feel they are adequately rewarded for the contribution they make. In such situations the most one might hope for is a project leader who, as mentioned earlier, merely acts as a coordinator and not as a positive leader and who hopefully does not become too demotivated by the task he has been given and the environment in which he is forced to operate.

Coordination is even more difficult when different institutional groups are involved. For example the relationship between government research establishments, universities and industry could be improved in many countries.

Movement of people between these sectors is less easy, as is the use of organisational overlaps, because of the autonomous nature of many of the institutions. Some attempt has been made to change things recently through the introduction of the customer-contractor type of principle, but it must be emphasised here that it is the communication and information transfer problem that is really being tackled, and not just the financing of R and D.

This brings us round to the final point on information transfer and management, and it is very simple and very important. R and D in most organisations is done for a purpose, and that includes most basic research. It is aimed at meeting some agreed objectives, even if they are a long way into the future and not too clearly defined. Two questions must therefore be asked, and at regular intervals. Firstly, have the objectives changed, and do we still want the output of our current project or programme, and in the form it is likely to appear? Secondly, is R and D still the best way to achieve the ends? As mentioned earlier, there are many examples of changes in the environment, in the needs and in the constraints which can reduce the value of an R and D programme. Information of a non-technical nature must therefore be made available to all project leaders, or perhaps more importantly, they should be encouraged to identify and consider such information at regular intervals, but they must be provided with a good deal of support in this area. Considerable help can be given by the organisation through the provision of information in the form of scenarios or alternative futures, against which the projected outputs from research projects and programmes can be tested. Collection and collation of information for this purpose is no easy task, but if it can be set down in a suitable form it can also throw considerable light upon the risks associated with the implementation and use, as distinct from the scientific and technical, aspects of R and D work. Such information is of value at start-up of projects and, if regularly updated, at subsequent reviews, with project leaders and team members being more aware of the factors which must be monitored and which, if they change, could lead to significant revisions in their work programme. This knowledge can prevent much of the demotivation which can occur if projects have to be changed because of outside influences which many project leaders in the past have not felt are their concern or perhaps have not been asked to consider. Involvement in the scenario writing process and the acceptance that many factors of a non-technical nature can affect their projects will lead to a more cooperative working environment and an improvement in information flow across the whole organisation. If this is accepted the review of projects can become much more effective and more positive than has often been the case in the past with relevant information inputs being more easily identifiable and subsequent actions more easily agreed and implemented.

Discussion and Conclusions

The questions of how much communication and what information to transfer are difficult ones to answer in general terms. There could be circumstances in which too little is bad, and some in which too much could be worse. The major determinant must be the needs of the project or programme and of the people concerned with managing it. The point made in this short review is that most benefit will be obtained if individuals, groups and the organisation can recognise what is required of them at particular points in time. Everybody must be aware of his own limitations and of the support he requires from and must give to others. Some of the important barriers to consider are those of a personal nature, the psychological cost, rewards, the not-invented-here, the lack of willingness to recognise that things are not going well, or that the outside world is changing. Although not specifically emphasised here there is room for the introduction of a variety of formalised procedures for recognising that new information inputs are needed and for identifying how they might be encouraged. There is also plenty of scope for the introduction of management development exercises which will help people to understand their own limitations and how they might operate better to their own and the organisation's benefit.

To do this it is necessary to recognise the importance of improving the ability of everybody as individuals to communicate and to be receptive to new information inputs. In addition it is necessary to improve the general atmosphere within each group and within the organisation to encourage a more cooperative and receptive environment. Organisational development can be, and needs to be, approached from both ends. At the same time every R and D manager as well as the organisation as a whole should consider the way in which rewards and recognition, not necessarily only in the monetary sense, are allocated and the effect this has on motivation and performance.

In conclusion one might ask whether we are trying to make an issue of something which is not really a problem. Doesn't everyone in R and D communicate? Don't we all keep open minds to the need for information? What is different now from the past? On the first two questions the research findings suggest the answer is most definitely NO. On the third question the important point to note is that the situation in which we now operate is very different from the past. More uncertainty, less spare resources, more awareness of the environment mean R and D must be more effectively utilised, and it is argued that more attention to making information transfer more positive at the individual, group and organisation levels will be an important step in the direction of making better use of the scientific and technical resources at our disposal.

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INFORMATION TRANSFER
COST/BENEFIT ANALYSIS

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SUMMARY

This paper provides a framework for performing cost/benefit analysis of information transfer systems. This framework is based on subdividing the system into its principal information functions, products and services and activities. A cost model is developed for each of these components consisting of cost factors such as number of journal articles (for primary information systems), number of searches (for secondary information systems) and cost elements such as labor, equipment, supplies and so on. On the other side, processes associated with each system component can be assessed concerning such measures of performance as quality, accuracy, timeliness, speed of delivery and so on. The performance has an impact on users which is the effectiveness of an information product or service. The consequences of the system, which are the benefits derived from it, can also be evaluated. Improved performance and effectiveness is assumed to lead to increased benefits which can be measured in terms of value, social benefit and so on.

The purpose of this paper is to provide a framework for evaluation of information transfer systems using cost/benefit analysis as the principal basis for evaluation. The paper does not purport to provide either detailed mathematical models or descriptive methods for evaluation. It presents, rather, an approach to evaluation that can be employed at several levels, whether one is concerned with a national information transfer system or, at the other extreme, a small operational system. The approach also applies to entire systems as well as individual information transfer products or services. Thus, the fundamentals presented here apply to nearly all levels and types of information transfer systems.

It is assumed that evaluation is of interest to managers to assist in policy making, planning or specific decisions concerning an information system, product or service. Evaluation can be the basis for policy making or planning. However, it is most often employed to make specific decisions concerning information systems, products or services. These decisions may be to design or implement a new system, product or service; modify an existing one; or even to discontinue a system, product or service. In order to make meaningful policies and plans or to arrive at reasonable decisions one must be able to describe it in a quantifiable manner.

Evaluation implies that one should "set a value" on a system, product or service. However, there has been a great deal of confusion concerning what to measure and how to make measurements. One hears about such measures as cost, performance, effectiveness, efficiency, productivity, and benefits. In this paper we attempt to illustrate the differences in these measures so that one has a meaningful framework for conducting evaluation and for choosing useful measures for evaluation.

First, it is necessary to discuss information transfer systems and to describe them in a manner that demonstrates the differences in the measures mentioned above. In order to do this, we will use two examples of studies performed by us in the past. The first example deals with an information transfer system that is national in scope [1]. This system involves journal publishing. It has many participant groups, such as authors, publishers, secondary organizations, libraries and readers, that are part of different entities and even sectors of society. Here, the objectives and incentives of the participant groups may not be in harmony. Yet, from society's viewpoint there is a common objective. The second involves an on-line retrieval system that is found in a single organization such as a university, company or government agency [2]. Here, all the participants including searchers and users are employed by that organization and their ultimate objectives are common to the organization's mission, goals and objectives.

Every information transfer product or service can be described by the numerous activities that go into its making or operation. For example, in journal publishing there is editing, redacting, composition, proofing, printing, collating, binding, and mailing. In on-line bibliographic searching there is formulation of search requirements, selection of a data base, formulation of search queries, actual searching, computer printout, screening output, presentation of results to a user, and use. Each activity can be described by the processes employed as well as the units of input and

output. The point here is that all information products and services are the sum of many such activities.

On a larger scale, information products and services usually are part of a larger system. For example, publishing journal articles is only part of a system that involves many participants and several generic functions that must be performed. Similarly, on-line retrieval in an organization involves participants and functions performed outside of the direct search service. In each case, the generic functions are those that must be performed in order for a system to operate. A generic function can be performed by several information products and services or participants. For example, distribution of journal articles to readers can be accomplished by individual journal subscriptions, library copies, photocopies of interlibrary loans, photocopies from a colleague's issue, and reprints. Identification of needed information can be achieved by on-line search as well as manual searches, references from colleagues, and citations in publications.

The sum of all functions makes up an entire system. In the broadest context, let us first examine a national journal information transfer system [3,4]. This system is depicted by the schematic model shown below in Figure 1. This diagram represents an information transfer spiral based on published documents, although the functions described in it are applicable to other forms of communication as well. The spiral includes ten functions that are essential to complete the transfer of information.

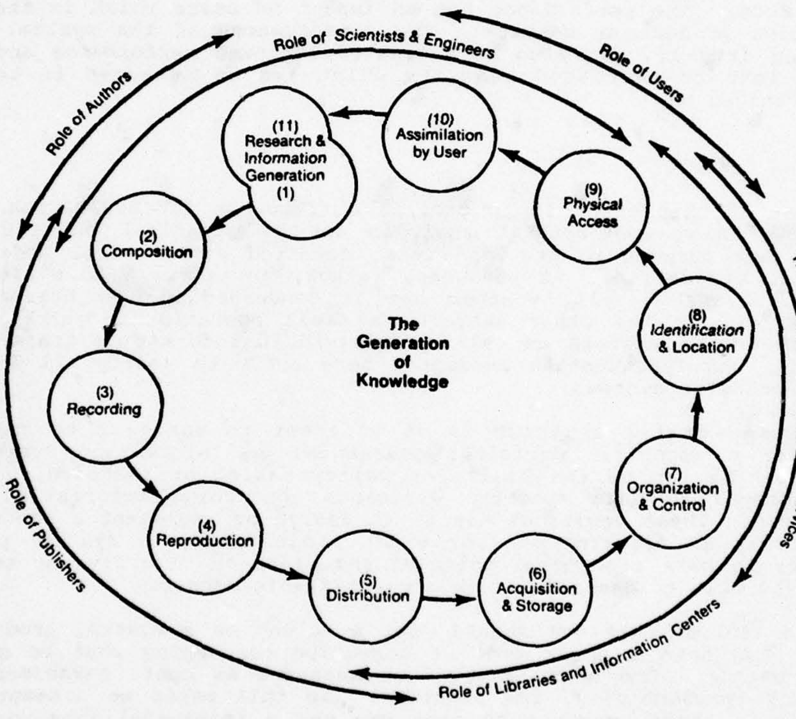

Figure 1. Scientific and technical information transfer.

The spiral begins at <u>Research</u> which results in <u>Generation of Information</u>. This function is the role of scientists and engineers. As a result of scientific research projects, manuscripts [books, articles, reports] are <u>composed</u>. The composition function refers to formal writing, editing and reviewing of the manuscripts. When a manuscript is in a form to be communicated it is considered to be <u>Recorded</u>. These two functions are the role of authors, publishers and other scientists when editing and review are performed.

The <u>Reproduction</u> and <u>Distribution</u> functions are usually the role of the publisher of scientific materials. However, the authors, libraries and colleagues also play an important role in reproduction and distribution which cannot take place without <u>Acquisition and Storage</u>. Libraries also have an important role to play in <u>Organization and Control</u> functions. In addition to collecting publications, libraries and other information centers provide access to these documents through cataloging, classification, indexing and other related procedures. The major indexing and abstracting services and bibliographic services play an important role in organization and control as well. Needed publications may be <u>Identified and Located</u> by a number of processes including reference to one's own subscription, library search and, recently, computerized search and retrieval systems. This function is usually accomplished by the user or an intermediary from a library or other information service.

The Physical Access function may include direct distribution of S&T articles from publishers to users as well as indirect distribution through libraries and other information centers. The final function in the spiral, that of Assimilation by User, is the least tangible. The assimilation function is the stage at which information [as opposed to documents] is transferred. It is at this stage that the state of the user's knowledge is altered. The functional framework is presented as a spiral because the communication process is continuous and regenerative.

A similar functional spiral is involved in information transfer of bibliographic publications. Bibliographic information such as abstracts and indexes must be composed, recorded, reproduced and distributed just as is done with publication of the primary literature. Distribution may be in the form of published materials or computer data bases which are in turn used for on-line searching. Such data bases also involve acquisition and storage as well as an organization and control which are the role of search organizations. The physical access and identification and location functions are performed, in our example, in a university, company or government agency.

Evaluation of information transfer products or services often involves their specific activities. That is, the evaluation is directed toward specific processes that are of interest. Such evaluation involves two general types of measures depicted in Figure 2 below.

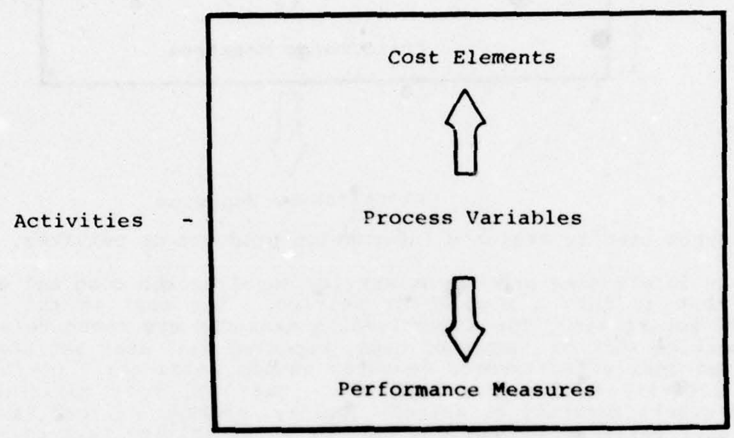

Figure 2. Measures used to evaluate information transfer activities.

The process variables include the type of equipment, personnel, and supplies that are used in the processes necessary to perform each activity. The equipment can be characterized by its general type (e.g., hot lead typesetting versus computer controlled photocomposer) or specific brand or model. Personnel can be characterized by their experience, training, age and so on. In each instance, the equipment, personnel and supplies should be characterized by their likely relationship to either cost or performance.

Cost elements are those measures that must be made to establish the cost of an activity. They include such measures as equipment rates and capacity; personnel salaries, rate of production and capacity; and unit cost of supplies. Other cost elements include number of units of input and output. Finally, the last cost element of importance is the allocation of overhead, administrative and facilities costs to an activity. All of these cost elements can then be modelled to establish the cost of an activity. The activity performance measures include such measurement criteria as quantity of output, accuracy, quality, and speed. Specific measures of on-line search accuracy might be recall, precision, and fallout [2,5]. It is emphasized that both the cost elements and the performance measures are related to the activity process variables and are, therefore, under the direct control of management. Search by more experienced staff should yield greater search accuracy but also may cost more. Almost any change in input, process or output will influence both cost elements as well as performance measures. Thus, one can and should be able to evaluate the cost and performance of any decisions that might be made concerning activities of an information product or service.

Productivity measures usually involve the productivity of labor, although one could think in terms of equipment as well. These measures are often expressed in terms of units of output per unit of staff. Examples might be number of items catalogued annually per person or number of articles edited annually per person. Thus, activity productivity measures are a ratio of performance measures and cost elements.

On a broader scale one may wish to evaluate an entire information transfer product or service and not just an activity. Here again, we find two general types of measures as shown in Figure 3.

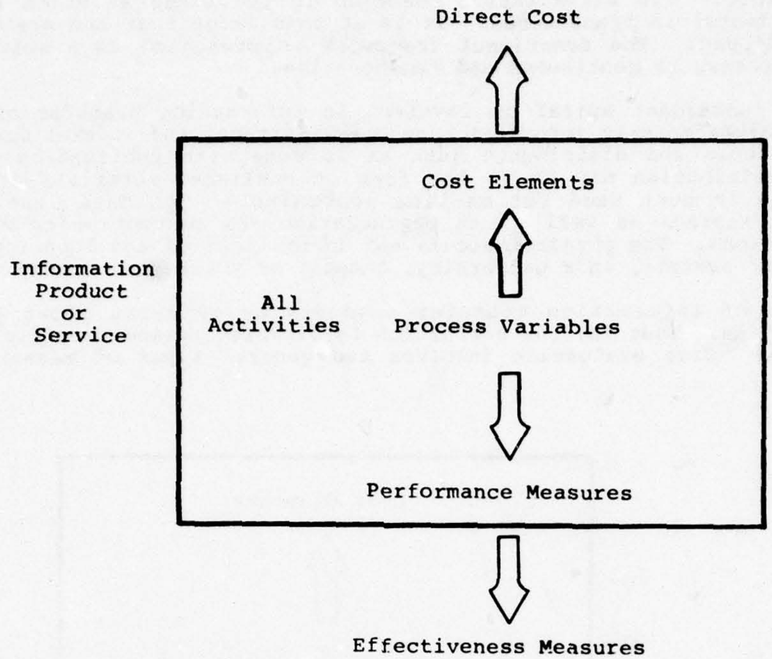

Figure 3. Measures used to evaluate information products or services.

Evaluation of an information product or service involves the cost and effectiveness of all activities that go into a product or service. The cost is the sum of costs established from all activities. The effectiveness measures are those related to users of the product or service such as number of uses, repeated use, user satisfaction and so on. It is emphasized that effectiveness measures should be directly correlated to (or dependent on) the activity performance measures. That is, user satisfaction should depend partially on search accuracy or article quality. Number of uses is also related to such factors as user satisfaction, price, ease of accessibility, awareness and so on. In a modelling sense, multiple regression might be applied where an effectiveness measure is the dependent variable and performance measures, along with the other factors mentioned above, are the independent variables. Even though effectiveness measures depend to some degree on performance, they are not under the direct control of management since these measures are largely from the perspective of users. Similarly, the direct cost is not entirely under the direct control of management since part of the cost is a function of the number of uses.

Product or service productivity measures are found by the ratio of effectiveness measures and cost elements. Examples here include number of searches performed annually per person or number of books circulated annually per person. In both activity as well as product or service instances, the productivity measures are often used as standards upon which to compare the operation of an organization. For example, libraries or abstracting and indexing services are known to do this. Efficiency of an information product or service is often measured by the relationship of total cost and effectiveness measures such as number of uses per unit of cost. An example might be number of searches per $1000 or articles read per $1000.

Another important facet of evaluation concerns when a product or service is distributed in a market-like environment. As mentioned above, the demand (or number of uses) is partially dependent on the price of the product or service. As shown below in Figure 4, the demand of the product increases with a decrease in price. The revenue to an organization is the product of the price (P) and demand (D) represented by the shaded area in Figure 4. In a sense, this could be considered a measure of effectiveness of the information product or service.

A similar curve is found for average cost and demand as shown in Figure 5. The total cost at demand (D) is the product of average cost (C) and demand (D) represented by the shaded area. Obviously, the net revenue (revenue minus total cost) dictates whether the product or service is profitable or not.

If one superimposes the cost/demand and price/demand curves upon one another the picture is much clearer as shown in Figure 6. When the price is at P_1 or P_2 the product or service operates at a break-even. A price above P_1 or below P_2, the product or service operates at a loss and between P_1 and P_2 at a profit. More will be said later about these relationships when we discuss entire systems and cost and benefit relationships.

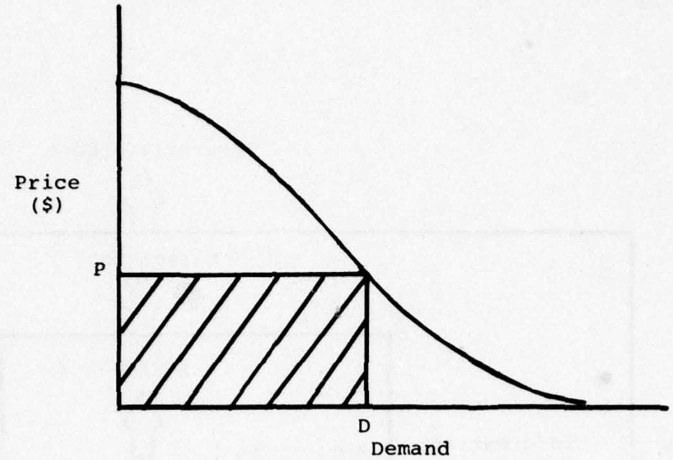

Figure 4. Price and demand relationship.

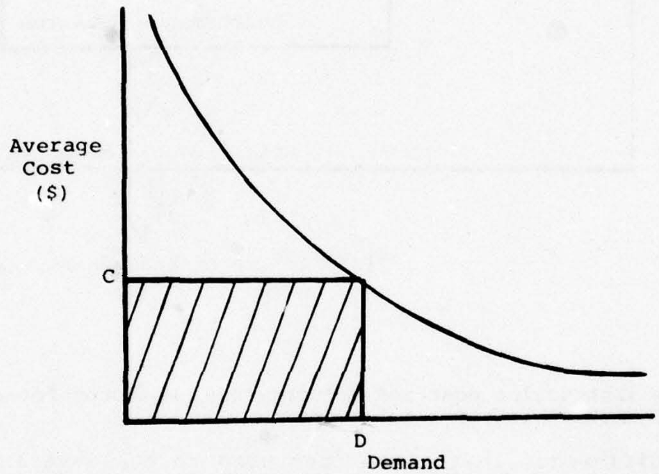

Figure 5. Cost and demand relationship.

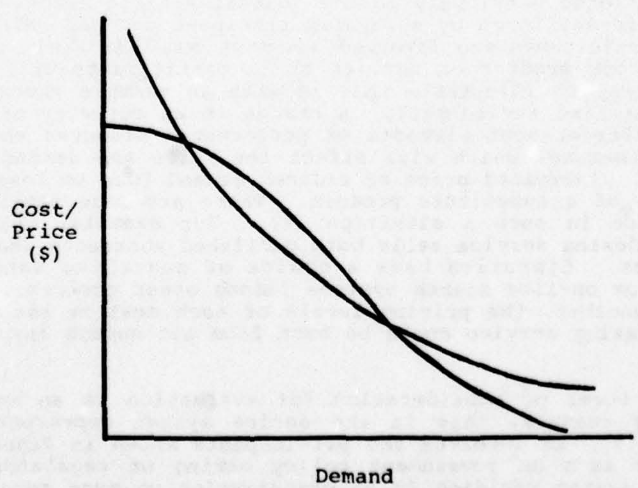

Figure 6. Cost and demand curve and price and demand curve.

Broadening the perspective even further, one may wish to evaluate a specific system function which may be performed through more than one product or service or through more than one participant. Measures for evaluation of functions are depicted in Figure 7.

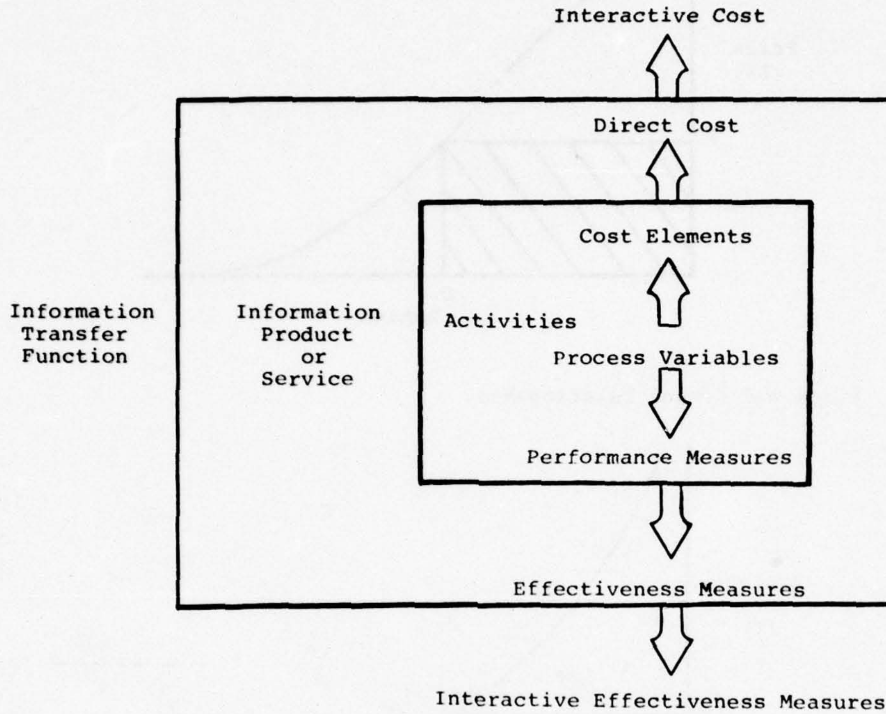

Figure 7. The interactive cost and effectiveness measures for evaluating information transfer functions.

The biggest difference in the measures used to evaluate information transfer functions is that users have options for obtaining information from alternative products or services or from different participants. In the on-line retrieval example, a search could be performed in any number of different ways by a user, an intermediary or a colleague. As mentioned previously in the journal article example, an article could be distributed in different forms by several participant groups. Since different products or services and participants are involved one must consider their interactive effectiveness. Changes in one product or service or in participants will affect all the rest. Probably the best way to illustrate this is with an example where products or services compete in a market-like environment. A change in an activity of a product or service will result in different cost elements or performance measures which will either alter the costs or use (demand) which will affect the price and demand relationship of that product or service. Increased price or reduced demand (due to lower performance) should result in more use of a substitute product. There are some subtle interactive effects that can take place in such a situation [6]. For example, this can happen when an abstracting and indexing service sells both published abstracts and tapes which are used by on-line systems. Libraries have a choice of searching manually from purchased publications or from on-line search systems (among other choices). If libraries choose one service over another, the pricing levels of each must be set very carefully or the abstrating and indexing service could be hurt from not enough income from the prevalent product form.

The broadest level of consideration for evaluation is an entire system. In the journal publishing example, this is the entire system represented by the spiral of functions previously. It involves the participants shown in Figure 1 as well as other influencing groups such as government policy making or regulatory agencies. In the on-line retrieval system residing in an organization we must consider the relationship to the other organizations functions as well as the information transfer functions performed outside of the organization (e.g., data base preparation). It is here that we finally arrive at the total cost and benefit measures as shown in Figure 8.

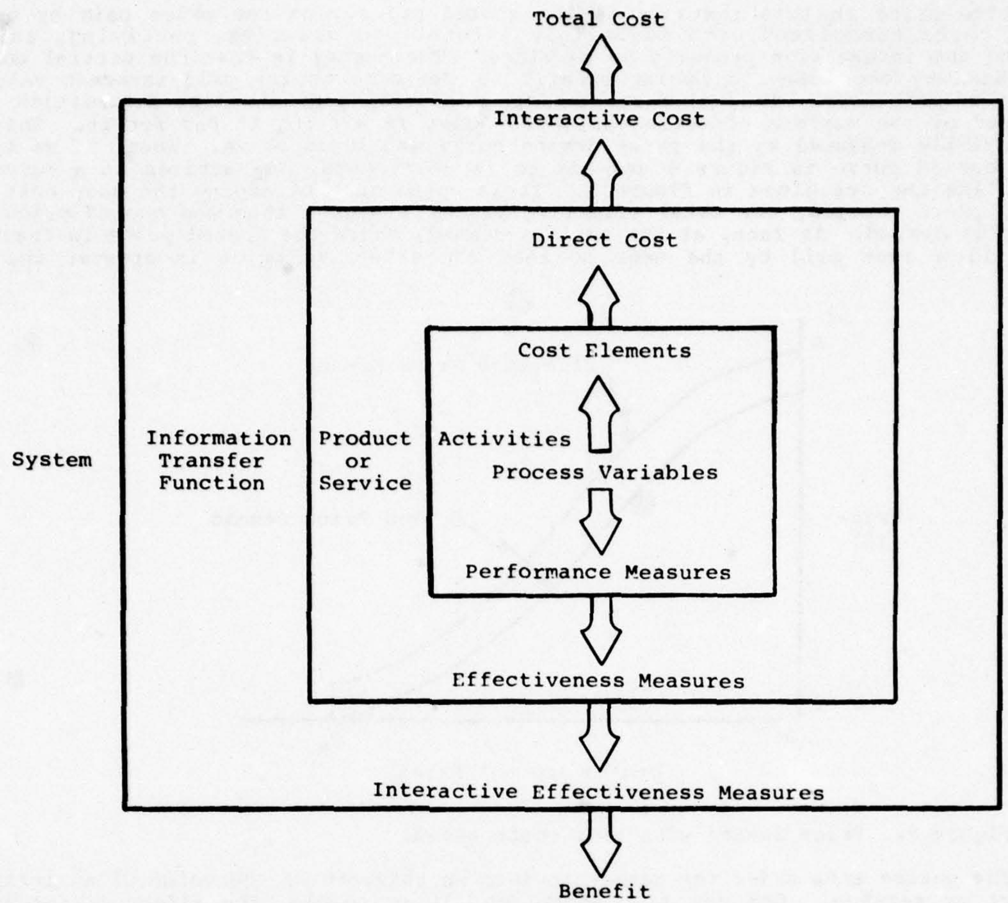

Figure 8. The total cost and benefit measures for evaluating systems.

The total costs of a system include all direct as well as hidden costs in the system. For example, in the journal system we have included author preparation costs, reviewer costs, reading costs and so on that make considerable contribution to the total costs [1]. In this instance, we were comparing electronic alternatives to paper-based publishing of scientific and technical articles. Thus, costs involving all participants, regardless of whether they are donated, hidden or direct. Clearly, the total costs then must begin with the cost elements of each and every identifiable activity in the system.

We consider benefits to be the consequences of the system. In a scientific and technical journal system we feel that these consequences should be considered in terms of their contribution to society such as in advancement in medicine and all that it implies. However, such social benefit is very difficult to measure. The same is somewhat true with systems that reside within an organizational entity. In a company the ultimate benefit might be to maximize profits, but it is hard, but certainly not impossible, to show how an on-line search system achieves this objective. Certainly cost of the search service can be compared to other search methods. Search service effectiveness in terms of the time saved by scientists can be roughly estimated. Some conjecture can also be made concerning the research being performed and its impact on company profits. Similarly, the ultimate consequences of search services on a university or government agency can be very roughly established.

It is our belief, that, faced with the difficulty of measuring ultimate benefit, one should attempt to establish measures that are highly correlated to benefit. These, one might refer to as surrogate measures. Just as some performance measures are surrogate measures for effectiveness (use), use is a surrogate measure for benefit. Presumably, more extensive use implies greater benefit. This depends somewhat on what the purpose of the use is. Reading articles for general knowledge would appear to have less value than to apply to research. The point is that any measure of performance, effectiveness or interactive effectiveness should be chosen based partially on its apparent relationsip to benefit, including the system's mission, goals and objectives.

Attempts have been made to establish value of a system, product or service in terms of time saved, reduced amount of research necessary and so on [7,8]. Another approach suggested by economists can be applied to products or services in which a price is used. This economic theory provides a partial estimate of the value of information based on the effective price users are willing to pay for information [9,10,11]. The

effective price in this instance is the quoted price plus the price paid by users in their costs associated with identifying, locating, ordering, receiving, using and storing the information products or services. The theory is that the partial contribution made by each user to social benefit is the same as the self-interest value perceived by that user. The value realized from providing a user with information is then measured by the maximum effective price the user is willing to pay for it. This price is partially measured by the price demand curve mentioned above. Thus, if we take the price demand curve in Figure 4 and add to it user costs, one arrives at a curve something like the ove given in Figure 9. It is noted that by adding the user cost to the quoted price charged, the total effective price is higher than the quoted price at all levels of demand. In fact, at the maximum demand, where the quoted price is free, there is still a cost paid by the user so that the effective price is greater than zero.

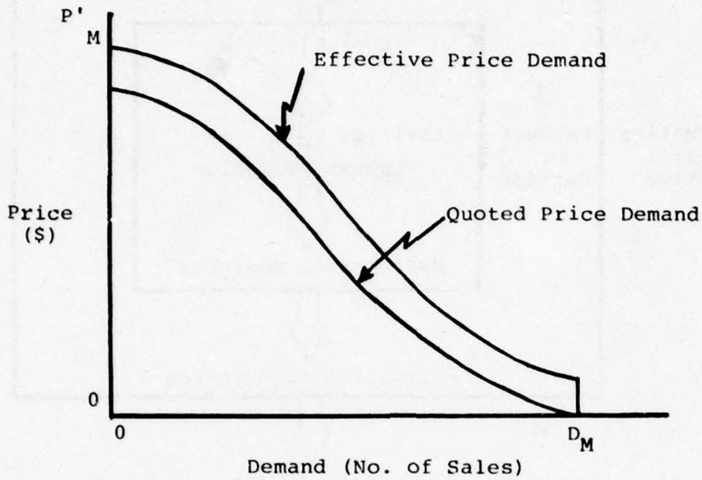

Figure 9. Price demand with user costs added.

The entire area under the curve provides an estimate of the value of an information product or service. One can also establish, in principle, the affect different price levels have on the value derived by society. For example, assume that a price charged to a product or service is P_1 and that the total effective price (including cost to user) is P'_1. Then the demand (D_1) is given as shown in Figure 10. The total value received by all users who purchase the product or service is the area under the effective price demand curve to the left of the vertical line at D_1 and intersecting the price demand curve at P'_1. This area is shaded in Figure 10. One can better understand this assessment if the area under the curve is subdivided into two parts: the rectangle formed by the effective price (P'_1) times the demand (D_1) and the area above the rectangle. The rectangle represents the effective price times the demand at that price. This is a clear indication of the total value represented by that particular price. However, some users are willing to pay more than that price which means that they place a higher value on the information than what they had to pay for it. This excess value is represented by summing over the area above the rectangle. The net value of the information is the total social value derived minus the total cost. This is approximately represented by the cross-hatched area in Figure 10.

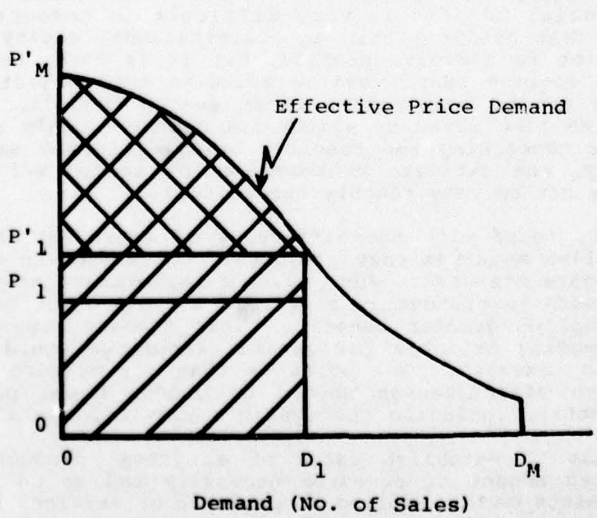

Figure 10. Price demand curve with user costs added.

It is noted that the total value is that which is actually received by users. Thus, the remaining area under the curve (to the right of the vertical line intersecting the effective demand curve at P'_1) represents the value to society that is lost because users are required to pay (P'_1) for the information. If the price were zero, presumably all needed information would be demanded (used) and social value would be increased. Conversely, if the price of information is increased, the value to society is decreased.

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EVALUATION OF INFORMATION SERVICES: RESEARCH AND REALITY

by

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SUMMARY

The first part of the paper comprises a brief review of the state of development of evaluation philosophy and methods, based on a recent publication by Professor Lancaster. This illustrates the broad scope of evaluation techniques that are required for different types of systems and services.

The second part of the paper describes the approach used by the Aslib Consultancy Service in evaluating information services. Here the philosophy is essentially that one must first accurately define the objectives of the service by careful analysis of the information requirements of the organization. Experience shows that sophisticated evaluation techniques are seldom needed to diagnose the faults of a service once objectives have been properly determined.

INTRODUCTION

Evaluation and system design are two sides of the same coin. If a system has been designed for a particular purpose, we can evaluate it by measuring the extent to which it fulfills that aim. The design of information systems is far from being an exact science, and our methods of evaluation are correspondingly limited, but nevertheless important. Technical development in both areas must proceed in parallel.

My work as a consultant these past ten years has consisted mainly of designing, improving and evaluating systems. These activities are essentially what I do for a living, and, as is often the case with such professional activities, one tends to treat the capability to perform them as something natural - not to be examined or questioned too often. But I do use information (unlike so many of those wretched "information users" one has to deal with), and I try to keep up to date with new developments in evaluation and design techniques.

Thus it was not remarkable that when I received the invitation to present a paper on evaluation of information services there happened to be on my desk a copy of a recent work by Professor Lancaster - his UNISIST Guidelines for the Evaluation of Information Systems and Services. (1) What I propose to do here is use these guidelines as the basis for a quick overview of evaluation techniques and evaluation philosophy, and then to hang on this framework some discussion about the realities of system evaluation based on the experience of my department.

EVALUATION PHILOSOPHY AND METHODS

Lancaster's guidelines begin with a statement that the major function of any information service is to act as "an interface between a particular population of users and the universe of information resources in printed or other form (documents)." I was sorry to see that final qualification in parentheses because I oppose the notion that an information service should be solely concerned with documents; but never mind.

The performance of an information service must be judged in terms of how successful it is in fulfilling this interface role. Specific measures of the success of an information service, says Lancaster, will mostly relate to the accessibility of documents and of their contents, and important criteria for evaluation will include:

"1. The extent to which documents most needed by users are available in the centre's collection.

2. The extent to which these documents can be found by users, in the collection, at the time they are needed.

3. The extent to which documents not in the centre's collection can be identified and acquired when needed by users.

4. The extent to which the service is able to bring to the attention of users those documents, or data within documents, most relevant to their various information needs, through literature searching and related reference activities."

The three major activities of an information service are defined as:

- the acquisition and storage of documents;
- the organization and control of documents;
- the distribution of documents or of information concerning the documents by means of various services.

The first two items above are referred to as technical services, and the distribution activities are the public services.

Technical services must be evaluated in terms of: (a) their internal operating efficiency; and (b) their impact on public services. Public services must be evaluated in terms of the extent to which they meet user needs. Different basic types of user need have corresponding areas of evaluation methodology. The extent to which a library can fulfil user needs for known items is measured by various forms of document delivery test. The extent to which subject needs are satisfied calls for evaluation of information retrieval capability. In a later section, the guidelines refer to three levels of evaluation:-

1. Effectiveness evaluation.
2. Cost-effectiveness evaluation.
3. Cost-benefit evaluation.

They go on to say that "An evaluation of effectiveness is an evaluation of user satisfaction". I would have preferred to say that it was an evaluation of the extent to which the service meets the need of its parent organization or community. I would not question the statements which follow, defining the other levels of evaluation. A cost-effectiveness evaluation is one that relates measures of effectiveness to measures of cost. A cost-benefit study is one that attempts to relate the costs of providing some service to the benefit of having this service available.

EVALUATION CRITERIA

The next part of the document deals with evaluation criteria which, it points out, should relate to the objectives of the system. These, as I know only too well from my own experience, are often ill-defined or even entirely absent. Generalized statements on the objectives of libraries and information services can be highly contentious. Hamburg (2) is quoted in the Lancaster guidelines for his suggestion that the basic objective of a library is the exposure of users to bibliographic resources. Lancaster suggests that this notion might be expanded to say that a reasonable overall objective for libraries and other types of information services is to optimize the exposure of users to documents or information, to optimize the accessibility of documents/information to users, or both of these.

At this point, having looked at objectives, it is possible to propose criteria by which information services may be evaluated. Lancaster's list is reproduced as Table 1.

Table 1 Some Criteria by which Information Services May be Evaluated

1. COST
   A. DIRECT CHARGES
   B. EFFORT INVOLVED

2. RESPONSE TIME

3. QUALITY
   A. COVERAGE (COMPLETENESS)
   B. RECALL
   C. PRECISION
   D. NOVELTY
   E. ACCURACY OF DATA

4. COST-EFFECTIVENESS (COST/QUALITY)
   A. COST PER RELEVANT ITEM
   B. COST PER NEW RELEVANT ITEM (NOVELTY-COST RATIO)

This list is extremely important both from the point of view of evaluation methodology and systems design.

The guidelines continue with an extended section on the evaluation of specific services. This covers the following:-

Evaluating the collection.
Evaluating document delivery capabilities.
Evaluating question-answering systems.
Evaluating literature searching systems.
Evaluating computerized information retrieval systems.
Evaluating machine-readable data bases and service centres.
Evaluating the catalogue.
Evaluating technical services.
Evaluating automation activities.

For each of the above, a summary of various evaluation techniques is presented together with a discussion on features and problems relating to each type of service. As might be expected, the sections on literature searching and IR systems are particularly complex, with their fairly detailed explanation of the techniques and pitfalls of measuring recall and precision. The section on evaluation of technical services is also noteworthy in that it deals with a number of formal methods of evaluating the efficiency of procedures and operations.

Thus, in about 200 pages is the sum of knowledge about information systems evaluation condensed, at least up to January, 1977, when these draft guidelines were prepared.

I make no apology for quoting so extensively from another work. It would be almost impossible to write a paper on evaluation without quoting Lancaster, and it seemed appropriate in any case to begin with a brief review of the state of the art.

"THE BENEFICIAL LIBRARY"

I should also like to mention another interesting document (dated July, 1977) that is relevant here. This is entitled "The Beneficial Library" and is the result of a three-year research project funded by the British Library R & D Department. (3) The authors attack strongly the notion of exposure as the main objective of a library. In this context they quote a respondent in another research study who commented: "The importance of information can be overrated. More information does not always result in increased knowledge and seldom produces increased widsom".

The key to the approach adopted by Wills and Oldman in their research is given by their statement that "The benefits of a library are most convincingly demonstrated by identifying its role in the organizational environment in which it is situated". This is very much in line with the thinking of my own department, as will be evident from what follows.

EVALUATION ON A CONSULTANCY BASIS

Much of the evaluation methodology which comes within the scope of the Lancaster guidelines is inapplicable for the kind of consultancy work that we do, either because it would cost more than most of our clients are prepared to pay (for the result achieved), or - more often - because it does not fit the kind of situation we are asked to study. For example, much evaluation research has been done in an academic environment, where the service and the users have very different characteristics from those found in industrial organizations. Most important of all, the users in an academic environment are generally individuals with little in the way of corporate objective; in an industrial/commercial environment, the information service has to justify its existence by supporting the objectives of the organization concerned.

Out of the list of specific service evaluations given earlier, the ones with which we are most commonly concerned are document delivery, question-answering, literature searching and technical services; although it must be admitted that our methodology is somewhat lacking in textbook elegance. The story usually begins with an organization asking us to evaluate their (existing) library or information service, and to advise them on its future development. The organizations concerned range from industrial firms. large and small, through national institutions and government departments, to international agencies. It is virtually unknown for these client organizations to have any detailed statement of objectives of their libraries against which performance can be measured or assessed, so our first response is to help them determine what these objectives should be.

OBJECTIVE - SETTING

To do this we have evolved our own particular style of user survey - which is perhaps an inappropriate expression, with its strong statistical connotation. The aim is to build up a composite picture of the work of departments and individuals, and the information that is required to carry out this work. At the same time, we explore the relative importance of different information sources, both within the organization and externally. The scope and structure of the interviews we conduct is indicated by the typical interview checklist shown in Fig. I.

To obtain a truly representative picture of information needs in this way, it is important to ensure that the user population sample is properly structured. This may, of course, represent the population of a single department which the information service is designed to support, or an entire organization. The latter is the more common in our experience, which usually means that a wide variety of different professions and different levels of seniority have to be represented in the sample.

To conduct a survey of this kind with a team of consultants means that although the interviews have to be conducted in a fairly informal, friendly style, certain disciplines have to be observed in order that the results can be effectively combined and collated.

At the end of such an exercise, the desirable objectives of the information service can be expressed in the form of a specification, listing the services to be provided,

their scope, and their respective priority. Ideally, one should be able to attach some kind of value to all the criteria listed in Table I, though not all of these will be quantitative. For some criteria, the values would in any case be different for different user groups. This in fact constitutes an important distinction between theory and practice in the design and evaluation of information systems: users are not consistent or homogenous.

Fig. I - Typical interview checklist

1. Name

   Position

   Section/Department

   Profession/Trade

2. Job

   - what does your department do?
   - what does your branch do?
   - what do you do?
   - what are you doing today?
   - what kinds of information do you need in your work?

3. Present sources of information

   - resources in own office/section

     filing systems
     private collections of documents
     indexes

   - resources within organization

     library
     registry
     colleagues

   - external resources

     libraries
     information sources
     personal contacts

4. Comparative value of different kinds of document (books, journals, patents, trade literature, correspondence, etc.).

5. Ideas/comments on services required

   - current awareness
   - retrieval
   - document provision.

EVALUATION OF RESOURCES

Having established the specification for the information service to aim for we can at last address the problem of evaluating the present service.

Examination of the information service itself will have been proceeding in parallel with the user survey. The goal of this part of the study is simply to learn as much as possible about the services, operations, procedures, staff and material resources available. A lot of information is needed on the scope of the collection, and on the accessibility of back-up resources - but at this stage we are seldom required to evaluate resources against any external model. We often find that accurate data on the volume of operations is lacking, and steps are taken to ensure that such figures are collected e.g. on numbers of enquiries and searches; and numbers of loans from the collection and from other libraries.

At a fairly early stage, having identified the kind of service that is needed, and having begun to examine the existing facilities, we can often identify points of weakness. The relative importance of these can be checked by highly directional questionnaire surveys addressed to the user population as a whole, rather than a sample. By concentrating on a few points, the questionnaire can be kept short and simple, and one can usually achieve a much better response than is otherwise possible.

DIAGNOSIS

When it comes to comparing the service specification with the profile of the existing service, there is in most cases little need for refined techniques to spot the disparities. Badly-designed services, inefficient procedures, inadequte or unbalanced collections, wrong allocation of resources - all the faults tend to stick out like sore thumbs. You must bear in mind, of course, that consultants mostly get called in to treat very sick systems. What we see is (hopefully) not representative of the general run of information services.

There are exceptions, of course. There was one organization in particular, a few years back, which had a library and information service that were excellent in many respects. They said to us, in effect, "our facilities have been developed to a certain quality (of which we are rather proud) but we want your advice on what our goals should be for the next five to ten years". In such a situation, the improvements to be gained are likely to be marginal, and more refined methods of evaluation have to be employed.

EVALUATION OF TECHNICAL SERVICES

So far, this brief description of our approach to evaluation has dealt with what the Lancaster guidelines call the public services - the services that the users are expected to enjoy. From time to time we are also required to evaluate the technical services. This usually involves examining in some detail the systems and procedures used within the library or information services. The techniques we use are either standard work study techniques, or adaptations of them, sometimes involving cost measurement.

At one level, this may simply involve flowcharting of procedures, which in itself can often provide damning enough evidence of bad systems and bad management. At other times, we have found ourselves masterminding quite complex diary-keeping exercises in order to determine precisely the effort (and/or cost) devoted to each operation.

The main point of this paper should by now be fairly plain. I wanted to emphasize that evaluation, to an information systems consultant, is more of an art than a science. We have to learn how to take short cuts in arriving at a diagnosis, rather than use highly sophisticated techniques. Clients are prepared to spend money on treatment, but reluctant to spend it on detailed study of what is wrong with their system. They are probably right in a way, for the methods of treatment at our disposal are sometimes as unrefined as our methods of diagnosis. The hardest part of the consultant's work lies in bringing about effective change toward improvement, in a way and at a rate that the client organization can tolerate - and at an acceptable cost. But all that is another story.

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Information and Assistance Services to the Manufacturing Industry in Canada

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SUMMARY

The Technical Information Service (TIS) of the National Research Council of Canada is a technology transfer service to assist manufacturing industry. TIS operates through field offices to ensure the most direct contact possible with industry. It provides a question-and-answer service in the field of science and technology, an engineering service to assist industry with its production problems and offers a program to keep industry abreast of new developments. The paper describes benefits to industry and government, as well as a recent student program to extend the assistance already given by its regular staff.

INTRODUCTION

It is widely accepted that advances in technical knowledge, research and development are essential factors in promoting industrial growth.(1)

The Science Council in Canada, along with many other bodies, has long regarded technological innovation as crucial to the maintenance and further development of a healthy manufacturing sector.(2)

A major problem in several countries has been to develop appropriate mechanisms of transferring technology to meet the needs of industry and especially of small and medium-size firms. In Canada, small and medium-size firms which we define as employing less than 300 employees, account for approximately 95% of all manufacturing enterprises, 50% of employment and 50% of the total manufacturing production. In general, they have great difficulty in obtaining and utilizing appropriate scientific and technical information. Typically, these firms do not employ engineers or scientists, are not able to identify or describe their true technological problems and have difficulty in using written technological information. They also have manufacturing productivities which are 20% to 25% below that of comparable countries.(3)

The Technical Information Service (TIS) of the National Research Council is the only federal government organization in Canada whose fundamental objective is to assist Canadian manufacturers to improve production operations, productivity and profitability through better utilization of existing technology and know-how in the production process.(4) It is one of the key links to overcoming some of the above problems by striving to serve some 30,000 firms throughout the Country.

BACKGROUND

The Technical Information Service (TIS) was established in 1945 expressly for the purpose of assisting the technical development of the manufacturing industry in Canada. The service, which in most cases, is provided without charge, draws upon the wide industrial experience and expertise of its own staff, the NRC laboratories, scientists and engineers in NRC, engineers under contract in Provincial Research Organizations and in other government departments and agencies, industrial sources, and foreign technical information centres for the information it supplies.

The service is characterized by an insistence that "technology transfer" to the small-business sector can best be carried out by means of competent technical people making personal contact with the firms they serve. The main feature of TIS is a field service with 16 offices in various parts of the Country staffed by 40 professional engineers and scientists who make "face-to-face" contact with industry. Approximately 50% of the field service is operated by Provincial Research Organizations under contract to NRC.

The field service receives backup assistance from 20 professional staff in Ottawa. They are university science and engineering graduates with several years of pertinent production experience in industry.

OBJECTIVES OF TIS

TIS is actively engaged in the process of technology transfer to industry, mainly to small and medium-size firms. "Technology transfer" refers here to the complete process of identifying problems, of searching for, acquiring, adapting and applying technology for productive and practical use in client firms.

The main objective of the Technical Information Service of the National Research Council is to provide industry in Canada generally, but particularly the small-industry sector, with the most direct access possible to current technology as it applies to the solution of industrial problems, and to assist directly in the use and application of this technology for the betterment of industry.

Its secondary objectives are:

1. To assist industry to get easy access to laboratories, libraries and any other sources of scientific and technical information located in the Council;
2. To assist industry to become aware and to make effective use of sources of scientific, technical and other information located outside the Council;
3. To provide direct assistance to industry in the application of the scientific and technical information thus available;
4. To help to establish NRC as a valuable source of technical expertise and information in the improvement of Canada's industry situation generally;
5. Finally, to encourage and assist agencies in the provinces according to their situations and resources, to carry out these objectives on behalf of NRC.

ORGANIZATION

The service is part of the National Research Council and reports to the Vice-President responsible for NRC's Industrial Programs. The total TIS staff is organized into two main sections: the field service and the "backup" head office in Ottawa.

- Field Service

TIS maintains about 40 field advisers in 16 field offices across Canada. Twenty of these advisers work directly for the Council, while the remainder are employed in the field services of the Provincial Research Organizations, which receive TIS contracts to cover the technical information part of their activities. The field advisers have considerable industrial experience and are key men in the organization. In addition to providing information, they offer concrete "on-the-job" technical assistance and practical advice to firms to help increase efficiency and productivity.

A key factor in the successful operation of TIS is that the technical advisers in the field offices work "face to face" with manufacturers in their factories -- either by responding to requests for assistance or by making unsolicited calls to the other firms in their territory. The offices are located to facilitate direct communication. In fact, 80% of the firms are within 50 miles of a given office.

- Ottawa Office

The Ottawa office is organized into three main sections: the Scientific and Technical Advisory Service, the Manufacturing Science and Technology Service (or Industrial Engineering Service) and the Technical Awareness Service. The professional staff in Ottawa have university degrees in science or engineering and several years of production experience in industry. Their main role is to provide "backup" service to the field advisers.

The Scientific and Technical Advisory Section answers questions on a wide range of matters related to industrial processes, scientific and engineering problems sent in directly by companies or through the field advisers. Most major fields are covered including mechanical, chemical, metallurgical and electrical engineering, applied physics, food technology and other technological areas as well as standards and specifications. The service answers approximately 25,000 inquiries a year; that is, some 22,000 by field advisers and 3,000 by the head office advisers.

The Manufacturing Science and Technology Section or Industrial Engineering group, provides advice and practical skills related to improving production operations to companies which have no technical or engineering staff. Fields covered include methods improvement, work measurement, plant layout, materials handling, organization, quality and cost control and so on. This in-depth service is made available to some 1,000 industries a year.

The Technical Awareness Service operates from Ottawa to keep companies aware of new advances in technology and research applicable to Canadian industry. The service reviews, on a regular basis, some 800 journals, plus reports, books, etc., and selects documents of interest to the manufacturing industry. Clients who have submitted their profile of interest will receive computer-matched lists of titles of documents, copies of which can be sent to them for a small charge. Variations of this program, group titles by subject such as industry, techniques or materials. These subject lists are then offered to all manufacturing firms. Through this program, some 100,000 technical articles are requested by and supplied to clients' firms.

OPERATION

TIS considers that its direct "face-to-face" field delivery system for technology transfer is the critical element in assisting small and medium-size industry.

The small entrepreneur is usually confronted with a host of daily operating activities; this limits his ability to address problems and to seek technological improvements. He is usually not aware of them until they become major crises and also is not aware of technologies which can be helpful to his enterprise. Even if he is aware of his problems, he may not be sure of their nature.

Indeed, in dealing with his needs, the small manufacturer frequently finds it difficult to ask specific enough questions to permit a technology transfer to take place.(5)

Furthermore, he usually does not have access to research laboratories or testing facilities, nor does he employ any scientific or engineering staff, and therefore cannot readily utilize written technical information.

In Canada, 91.75% of industries do not employ engineers and 97.2% do not employ scientists.(6)

To overcome these problems and achieve optimum assistance for each client, TIS endeavours to apply the following seven-step ideal system.

(1) Correctly Identify and Define the Problem or Need

The client often not aware of problems and if he is, 80% to 90% of the time, he does not identify it correctly.**

Usually, problem identification and definition can only be done by visiting the clients' plant, talking with the managers and seeing the physical operation.

(2) Identify and Locate the Technology which is Appropriate to Solving the Problem or Filling the Need

This is done by using the field advisers' experience and, when necessary, the vast array of information available through TIS and NRC researchers as well as those of other government and private resources.

(3) Adapt, Modify and/or Interpret the Information for the Clients' Specific Requirements

This is done so that the client can understand and make use of the knowledge supplied to him, especially when the technical information is in a form of scientific jargon or language that a small entrepreneur may not understand.

In general, an "on-site" review of the written material is required to be sure that the technical data or information is fully understood.

(4) Assist in the Practical Utilization of the Information

In-plant assistance is often necessary in this phase of the transfer of technology and is accomplished by providing practical "on-the-job" suggestions and "know-how" gained from previous experience in industry.

(5) Follow up to Ensure Correct Usage

Even after providing the above assistance, problems may arise which can cause incorrect modification to be made to the system resulting in system failures. Proper follow-up will help minimize these problems.

(6) Review Adequacy of Solution

The final test of a good transfer is whether or not it succeeds in passing the test of time. Therefore, an "in-plant" review is worthwhile

**From years of NRC-TIS experience

to collect information on the adequacy of the solution, modifications that have been required and any "spin-offs" or innovations of technology that have occurred in the plant.

(7) Assessment of Benefits Derived

This step closes the loop in technology transfer. The benefits derived are assessed (i.e., profits, jobs saved or created, new product started, etc.)

- Positive benefits indicate a successful transfer.

- Unsatisfactory results indicate an unsuccessful transfer -- case to be reviewed for cause of problems and proper correction.

Obviously, TIS cannot follow this pattern for all cases and still maintain a country-wide coverage with a limited staff but it is the ideal that we aim for and do actually achieve in many of our field projects.

The value of the service is attested to by the number of repeat inquiries from satisfied clients. A recent study of TIS, made by an independent consultant, showed that 52% of clients used the service repeatedly. This occurs only because TIS is considered to be useful by clients who have experienced real benefits through this practical method of technology transfer.

Two other telling pieces of information were noted in the same study.

> "Clients appear to accept and trust the TIS field officer, particularly after he has demonstrated his sincerity and interest, often by literally rolling up his sleeves and working alongside others in the plant."

and

> "Recipient companies have found the Inquiry Service and Industrial Engineering valuable, backing up their statements with specific benefits and results in applying the information or advice received."

BENEFITS DERIVED FROM TIS ASSISTANCE

TIS assistance is of interest, not only to industry but to the government and the community in general.

Some of the direct benefits to the industry are: reduced cost of operations, reduced capital investment, increased gross sales, improved projects, etc. Indirect benefits accrued to industry relate to improved product or job quality, better management, improved staff morale, and enhanced technological level and ability to innovate. These benefits result in increased productivity and growth of the firms, help them to maintain their competitive position on the market and sometimes help the enterprise to survive.

Governments will derive additional revenue through more corporate tax revenue resulting from improved profits, increased taxes on increased sales and reduced unemployment benefit payments due to jobs saved or created.

Additional benefits to the community are in the form of better employment opportunities, improved environmental quality, better use of energy, material, financial and human resources, for example.

A recent five-year review (August 1977) [7] of only three per cent of TIS case histories, shows that $18.7 million in benefits have accrued for the 107 cases studied, and the federal tax return on the federal government's investment was a minimum of 136 per cent! In addition, 1,067 jobs were maintained or created. In other words, there was no cost to the federal government for providing TIS assistance to industry. In addition, over $2 million of tax revenue increase went to provincial governments.

SCIENCE AND ENGINEERING STUDENT PROGRAM

A recent addition to the service is the student program designed to allow an extension of TIS activities. TIS is currently launching a program by which science and engineering students will be responsible for carrying on short-term projects in industry.

The projects' eligibility is based on the technical merits and the increased use of scientific and engineering skills by the firm. Moreover, the projects are intended to produce significant benefits for the firm or the economy.

The projects are prepared by the firm with the assistance of the TIS technical adviser. They must not exceed four months in duration and must be of such a technical level that they can be handled by qualified science and engineering students who will

work under the close supervision of experienced technical advisers and/or university or college professors.

The program is primarily intended to help industry but has several other advantages as shown by the pilot project TIS conducted previously. It enables the student to familiarize himself with industry, makes industry aware of the value of scientists and engineers and helps universities to adjust their curriculum to better prepare the student for the real world. In addition, it adds some 40 man years of quality technical assistance to TIS itself.

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A review of technological, technical and scientific information services in DENMARK - 1978

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INTRODUCTION

To be representative, a review of the Danish National Programmes within our topic INFORMATION AND INDUSTRY must necessarily cover the Scientific and Technical Information and Documentation Services as well as the Technological Information Services.

It is not felt appropriate to give a comprehensive and detailed description but merely to outline the principal structure and characteristic differences in objectives and methods applied - just as describing how the present structure was brought about.

Background

While the Danish Economy up to the Second World War was relying upon Agriculture, Industrialization was a must after the war.

Denmark was in the fortunate position of having generations of traditions and skill of craftsmanship and of having a widely distributed school, education and library system.

As early as in 1906, industrialists became aware that to ensure updating of the skill and competence of craftsmen it was necessary to establish a Technological Institute with the aims of transfer by training of new technologies into enterprises. We now have two Technological Institutes, regionally located in Copenhagen and in Aarhus. (TI & JTI).

Improved skill and knowledge of craftsmen were not found sufficient why, in 1937, the Dean of the Technical University, professor P.O. Pedersen, together with the Federation of Danish Industries took the initiative to establish the Academy for Technical Sciences (ATV) to improve the communication between Industry, Public Authorities and the Technical University. ATV has now grown into a group of 20 autonomous applied research institutes.

The OEEC/EPA (the Organization for European Economic Co-operation/European Productivity Agency) stimulated the Danish Government to improve the communication between Industry and the infrastructure of National Capabilities by establishment of various services, among them a technological information service. DTO (Dansk Teknisk Oplysningstjeneste) was established in 1955.

The Library of the Danish Technical University, DTB (Danmarks Tekniske Bibliotek) was extended and became the Danish National Library for Technical Sciences serving Industry, Research, Science and Education. DTB improved its traditions in documentation and established a department specializing in advanced documentation services, now mastering manual as well as computerized services.

Stimulated by OECD (the Organization for Economic Co-operation and Development) and its Information Policy Group (IPG) the Minister of Education and Science instituted in 1970, via the Science Planning Council, a focus for Scientific and Technical Information Policy (DANDOK) to advise on coordination of information activities within all sectors and disciplines.

By a restructuring in 1973 of advisory councils for Science and Research, all Government support for the Sector of Science, Research and Education was gathered within the resort of the Ministry of Education, while Government support for the Sector of Technological Services and Applied Research geared towards Industry was gathered within the resort of the Ministry of Trade and Industry represented by the Technology Council (TR).

Information services are referred to follow that pattern - even if DANDOK is the umbrella policy body for all of them.

Present division of roles

To fully understand this division of roles, it is necessary to describe the structure of Danish Industry.

Only about 7,000 out of 90,000 enterprises providing goods and services are regarded industrial enterprises.

Of the 7,000 industrial enterprises only about 100 employ each more than 500 persons and only about 350 enterprises claim to have organized R&D.

We further know that out of the 7,000 enterprises only about 700 employ each 3 engineers or more.

This leaves Denmark with a demand for having a very diversified infrastructure of centres and services of specialized knowledge and capabilities acting as advisors and supplementary specialist capacity for industry. We can identify about 800 units (centres of specialized knowledge) in various areas, at various levels.

It further explains that more advanced information and documentation services (computerized) are merely of interest to the sector of Science, Research and Education, to Industrial Enterprises having their own R & D department and to the infrastructure of Centres of Specialized Knowledge.

DTB has an important role to play in training and serving these organizational units with documentation benefitting from Danish participation in EURONET and SCANNET and from the access to other services such as ESA/RECON, LOCKHEED, SDC, etc. Further, DTB coordinates technical library and documentation activities at Technical Colleges located in several places in Denmark.

Specialized research libraries and central technological information services such as DTO, TI & JTI will benefit from direct access to computerized services. They have further a special task in being intermediaries between the computerized services and especially the small and medium sized enterprises which are not familiar with or equipped to benefit from direct access to the computerized services.

That brings us to look especially upon the aims, objectives, programmes and working methods of technological information services for industry.

Information Services for Industry

Transfer and implementation of technological information x) into industry take place in two different forms - either information or consultation - the former being a "push-process", the latter mainly being a "pull-process".

That leads us to say - knowledge (technological information) is an intellectual raw material - a commodity - which has to be marketed.

Most industrial enterprises - particularly small and medium sized enterprises - do not

- realize that they have problems to keep up with their competitors,
- realize their need for improvement and innovation,
- master the diagnosis and formulation of what kind of information they need,
- know the pattern and competence of existing resources - domestic or foreign - and how to procure information from them.

They do not need documents, they need facts transformed into knowledge, explained in their language, and made relevant to their situation and understanding.

An information service for industry will therefore have the aims of stimulating, diagnosting, formulating, searching, procuring, analysing, evaluating, transforming, presenting and explaining how to implement, how to convert technological information into practical results and steps of progress.

It needs qualified, experienced, matured, business-oriented professionals being excellent communicators, who can convince people and get their confidence as working partners.

The programme of an information service for industry is:

- to call upon enterprises uninvitedly and to obtain a diagnostic interview assisting in formulating needs for information,
- to operate a confidential intelligence service on behalf of the individual enterprise to procure exactly the information that is needed - not more not less - and to transform, repackage and explain the evaluated information to the client - how to benefit from it,
- to keep alert towards other information or specialist consultation of interest to the various clients. (An active selective information service).

The information service for industry is a "pusher" to open for the "pull-process", why it has often chosen the policy that what is carried out on the initiative of the information service is provided free of charge - but when the client is apt to "pull", he has to pay a fee - because that is the only way he appreciates that technological information has a value as "the intellectual raw material".

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x) The FID/II's definition of technological information is knowledge - technical, economic, marketing, managerial, social, etc., which by its application will further progress in the form of improvement and innovation.

Instituting the information service for industry as the "pusher" also leaves the service with the task of promoting the consultative services - the centres of specialized knowledge - where competent specialists are prepared to work on practical problems presented to them.

Very seldom, specialists have the capabilities or patience of dealing with "potential" clients.

The Danish structure of Information Services for Industry is today:

DTO is the "pusher", utilizing foreign technological information, serving medium-sized and big industry as well as technological service units.

The central information services of the two Technological Institutes are the "pushers" utilizing mostly information transformed and repackaged by Danish specialists and geared to be appropriate for small enterprises and crafts.

To ensure that no enterprise, even how small it is, is left alone - there are under establishment a number of local TIC's (Technological Information Centres). Five are in existence, the plan being to have one in each of the 14 counties of Denmark.

A TIC will be manned by 1 economist, 1 engineer and 1 craftsman plus a secretary.

By extending the structure that far, we expect not only to channel technological information as effectively as possible to the widest circles of Danish Trade and Industry, but also to get an effective utilization of the potentials of knowledge established in Denmark and abroad.

We also believe to identify in "the market" those problem areas deserving public investment in Danish Applied Research.

We believe that a modern society must not only structure and diversify resources of intellectual raw material, but furthermore structure, diversify and specialize channels of communication, means of communication - coordinating the many approaches individually geared to various target groups of industrial enterprises.

The person-to-person transfer of technological information is regarded to be the most effective method. It may be costly but the social aspect of networking personalized services should not be undervalued.

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PROGRAMMES NATIONAUX EN MATIERE D'INFORMATION INDUSTRIELLE

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A l'encontre des grandes industries, les petites et moyennes entreprises ont un accès difficile à l'information en raison:

(1) de l'irrégularité de leurs besoins en information technique, ce qui ne justifie pas la création d'une cellule documentaire permanente au sein de l'entreprise;

(2) de la nécessité pour prendre les décisions en matière d'innovation technologique, de rassembler des informations de types différents et complémentaires (techniques – juridiques – économiques) et de les reconditionner.

Pour résoudre le problème de l'information industrielle, il s'agit d'une part de créer des structures nouvelles, et d'autre part de renforcer l'action de ces structures en créant des outils généraux adaptés à ce type de besoin.

Le BNIST s'est attaché dans un premier temps au premier aspect en intervenant au niveau de:

- l'orientation des entreprises vers les sources d'information par la création du service national d'orientation: SOS-DOC
- la création de structures implantées au niveau régional capables de répondre au besoins des PME en matière d'information technique – juridique – économique: ce sont les Agences Régionales d'Information Scientifique et Technique (ARIST).

SOS-DOC
SERVICE NATIONAL D'ORIENTATION VERS LES SOURCES D'INFORMATION

SOS-DOC a pour rôle de signaler l'organisme compétent pour répondre à une question précise aux utilisateurs en quête d'informations. Ces derniers appartiennent en majorité à l'industrie; mais bien entendu, SOS-DOC est ouvert à toute personne à la recherche de renseignements scientifiques ou techniques, et a reçu un certain nombre de questions posées par des correspondants exerçant leur activité dans l'enseignement (supérieur, technique . . .), la presse . . . etc.

FONCTIONNEMENT

Pour chaque question, SOS-DOC prend contact avec le ou les organismes susceptibles de fournir l'information recherchée afin de savoir quel est celui qui pourra effectivement donner une suite positive à la demande. Puis la réponse d'orientation est transmise à l'utilisateur gratuitement. A partir de janvier 1979, un forfait (peu élevé) sera perçu.

La réponse comprend:

- nom, adresse, n° de téléphone de l'organisme compétent (avec, chaque fois que cela est nécessaire, indication du service, de la personne à contacter);
- renseignements d'ordre administratif:
  - mode de formulation de la demand (lettre, téléphone, consultation sur place . . .)
  - coût de l'information qui sera fournie par l'organisme
- toute autre indication capable de faciliter pour le demandeur, l'accès à l'information.

Les organismes vers lesquels SOS-DOC "oriente" ses correspondants appartiennent à des catégories très variés: centres techniques industriels (service de documentation, assistance technique, laboratoire), bibliothèques publiques, universitaires . . . , services de documentation rattachés à l'administration, Fédérations et Chambres syndicales . . .

NOMBRE, TYPE ET DOMAINE DES QUESTIONS

Depuis 1978, le *nombre moyen de questions* se situe entre 350 et 400 questions par mois.

Sur l'année 1977, 1504 *utilisateurs nouveaux* se sont adressés à SOS-DOC sur un chiffre total de 3 537 questions posées.

Les différents *types de questions* les plus fréquents sont, par ordre d'importance, les suivants:

– adresse de sociétés commercialles d'l produit ou d'l équipement	17,9%
– adresse d'l source d'information	15,6%
– renseignements bibliographiques	12,5%

Les *domaines* sur lesquels portent ces questions sont par ordre d'importance.

– Mécanique	11,6%
– Physique – chimie	8,9%
– Agriculture – alimenation	6,7%
– Economie – Commerce finance	6,2%
– Bâtiment et T.P.	5,6%, etc . . .

LES OUTILS DOCUMENTAIRES DE SOS-DOC

Ils consistent en l'établissement d'un certain nombre de fichiers documentaires:

(1) *Fichiers utiles à l'orientation*
- fichier des organismes
- fichier de termes spécifiques: fichier type – index KWIC réalisé à partir de la raison sociale des organismes
- fichier matière ou fichier thématique.

(2) *Fichier utilisateurs*

Une fiche est créée à chaque fois qu'un organisme a recours à SOS-DOC.

Un rappel de la question est annexé à chaque fiche-utilisateur.

Une évaluation de l'orientation est demandée à l'utilisateur qui retourne une fiche spéciale que SOS-DOC lui adresse afin de déterminer si la réponse a été satisfaisante.

Cette évaluation permet à SOS-DOC de vérifier le niveau et la qualité des prestations fournies par les sources d'informations vers lesquelles il oriente.

A partir, de ces fichiers SOS-DOC vient de publier un répertoire des systèmes d'information français ou accessibles en France, édité par la Documentation Française.

LES AGENCES REGIONALES D'INFORMATION SCIENTIFIQUE ET TECHNIQUE (ARIST)

Implantées dans les régions, les ARIST sont composées d'équipes légères de quelques personnes, chargées d'ajuster l'information à la demande et de fournir une réponse "sur mesure". Elles jouent vis-à-vis de la PME le rôle des services d'information et de documentation existant dans les grands groupes industriels.

MISSIONS

Les agences ont pour but:

- de rechercher l'information nécessaire aux utilisateurs industriels,
- de fournir les services répondant à la demande,
- de sensibiliser les milieux de la recherche et du développement à l'importance et au rôle de l'information en tant qu'instrument du transfert de la technologie,
- d'assurer sur le plan régional, le relais entre les utilisateurs de l'information et les pouvoirs publics pour une meilleure définition et compréhension des besoins.

Recherche d'Informations

L'ARIST effectue, à la demande des utilisateurs, toutes recherches d'information dans les domaines scientifiques et techniques en utilisant tous les outils et services d'information existant sur le plan régional, national et international y compris les fonds "brevets et marques".

Fourniture de Services

A partir de ces recherches, l'agence fournit aux entreprises, aux inventeurs, aux laboratoires, l'information scientifique et technique sous la forme la plus appropriée et la plus économique en tenant compte avant tout des besoins précis des demandeurs. Elle met au point un dossier de réponse, sommaire ou plus élaboré selon les cas, qui comprend la somme synthétisée des informations recueillies.

Les principales prestations sont les suivantes:

- état de la technique (étude documentaire)
- surveillance technologique par exploitation périodique des fonds documentaires appropriés (périodiques scientifiques et technique, systèmes bibliographiques, brevets, marques, etc. . .)
- recherche de créneaux (produits, procédés)
- recherche de produits et procédés nouveaux
- pré-évaluation des produits et procédés nouveaux
- aide à la définition d'une stratégie de l'innovation dans l'entreprise

Sensibilisation

Chaque agence doit sensibiliser en permanence les milieux économiques et de recherche de la région à l'utilisation de l'information scientifique et technique pour le développement de l'industrie et de la recherche technologique.

PRINCIPES ET MODALITES DE FONCTIONNEMENT

Il est nécessaire d'implanter ces ARIST dans une structure d'accueil régionale bien établie et susceptible d'assurer une part du financement. A ce titre, les chambres régionales de commerce et d'industrie présentent un intérêt particulier. La liaison de l'ARIST avec les assistants de gestion industrielle des chambres locales est favorisée, et le travail de promotion et de sensibilisation de l'ARIST facilité.

Une ARIST pour fonctionner doit posséder une infrastructure documentaire minimum: une bibliothèque scientifique et technique (à proximité) un dépôt de brevets et des documentalistes susceptibles d'exploiter ces fonds.

Le budget d'une ARIST en période de croisière est d'environ 600 000 francs correspondant au personnel suivant:

2 ou 3 ingénieurs
2 ou 3 documentalistes
1 ou 2 secrétaires

Le BNIST assure le démarrage de l'opération pendant trois ans:

1ère année:	200 000 Frs
2è et 3ème année:	300 000 Frs
4ème année:	150 000 Frs

Ces chiffres peuvent varier suivant l'importance de l'ARIST.

Au terme de 4 années le budget de l'ARIST est financé par les recettes d'une part (auto-financement à 40% pour l'ARIST de Nantes) et le soutien de la Chambre de Commerce et d'Industrie d'autre part.

Il existe actuellement, neuf ARIST:

- Nantes
- Lyon
- Toulouse
- Marseille
- et Montpellier
- Tours
- Lille
- Strasbourg
- Nancy

Dans les trois prochaines années grâce à un financement du FIAT (Fonds d'intervention pour l'Aménagement du Territoire) leur nombre sera porté à une douzaine couvrant ainsi l'ensembe du territoire français.

Un exemple d'ARIST: le Service d'Information Industrielle, de développement et d'innovation technologique (SIDETEC) à Nantes.

Le SIDETEC situe la gamme de ses services dans le cadre d'un processus d'innovation technologique qui se pose à l'entreprise. Les besoins d'information s'exprimeront à l'occasion:

– soit d'une reconversion de l'entreprise
– soit d'une diversification des activités de l'entreprise ou du développement d'une nouvelle gamme de produits.

Deux phases peuvent être distinguées dans la démarche de l'entreprise:
– une phase d'approche
– une phase de réalisation

(1) *La phase d'approche*

Elle peut se décomposer en trois étapes:
– fixation des objectifs
– définition du créneau à occuper par l'entreprise
– choix des axes de développement

Le SIDETEC proposera une aide à la définition d'une *politique de produits dans l'entreprise* et donnera ses conseils pour l'établissement *d'une stratégie de développement de produits nouveaux.*

A ce stade l'entreprise doit connaître la *situation de l'environnement technologique* avant d'aborder la phase de réalisation.

Le SIDETEC établira donc un *bilan technologique*: recherche d'information auprès:
– des centres techniques
– des banques de données spécialisées
– documentation brevets etc. . .
– portefeuille brevets et marques de la concurrence

On peut alors aborder la 2ème phase:

(2) *Phase de réalisation*

Il s'agira pour l'entreprise de:

(a) *l'identification des produits*, le SIDETEC devra donc apporter son concours pour la recherche d'opportunités. Il aura pour cela recours aux banques de données sur les inventions cessibles et les transferts de technologie.

(b) le choix du *produit par l'entreprise*, et sa *pré-évaluation* par le SIDETEC; recherche d'antériorité et étude de brevabilité – étude du marché potentiel.

(c) *la décision d'investissement et l'introduction du produit sur le marché* qui impliquent de la part du SIDETEC des conseils en marketing et la recherche de partenaires.

Une fois le produit lancé et commercialisé, il sera toujours utile que l'entreprise *surveille l'environnement technologique* de son produit et que périodiquement elle ait recours aux services du SIDETEC.

Nous conclurons cet exemple des différents stades d'intervention du SIDETEC en disant qu'il offre des services très complets allant jusqu'à la fonction de conseil en organisation.

CONCLUSION

La politique du BNIST, en matière d'information industrielle s'est donc orientée dans un premier temps vers la création de structures nouvelles adaptées aux besoins des PME.

Il convient maintenant, à l'échelon national, de créer ou d'améliorer des outils d'information notamment dans le domaine du transfert de technologies, de catalogues industriels et de propriété industrielle.

A National Programme for U.K.

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Summary

There is in U.K. today no national programme on Information for Industry, but an interesting case can be made that there should be one. The services provided by the various interested parties are good, but there are gaps in the cover which might possibly be best met through a national Industrial Information Agency. The existing sources are outlined and attention is called to areas of concern.

A policy for execution by a U.K. national Agency should necessarily contain at least the following items:

(1) Use of Public Libraries as a universal access facility

(2) Compilation of commercial information and encouragement of commercial processors of this

(3) Establishment of Standards and Specifications Data Banks

(4) Encouragement of industry to contribute proprietorial information

(5) Promotion of training facilities for the new breed of 'Intelligence Officer'

(6) Promotion of corporate recognition of the value of the information resource, particularly by close association with ASLIB and CBI

(7) Establishment of an effective User Group as a part of the apparatus of the Agency, again, in cooperation with ASLIB and CBI

It remains, however, to be queried whether such an Agency would operate more efficiently than could existing bodies if only industry expressed its views and needs more clearly and effectively.

A National Programme for U.K.?

In U.K. we tend not to indulge in National Programmes. Certainly we have nationalised industries, but we do not have National Plans. Planning is something that other nations do. There is nevertheless a good case for a national information policy. This case was well made by Professor Meadows of Leicester University at the ASLIB Annual Conference last year (1). This Conference, as well as pointing the way to possible cooperative effort, also demonstrated the compartmented nature of U.K. thinking on this vital subject.

From the views expressed at Lancaster and elsewhere, one could draw up a policy paper - an outline of which will be proposed later - but there is a real problem about who will be charged with its implementation. The U.S.A. has (2) a 'National Program Document' and a 'National Commission on Libraries and Information Services', but the problems of a similar operation in U.K. are vast and, again, were well reviewed by Meadows.

So what is today the U.K. National Programme - such as it is? It is an aggregate of essentially independent efforts, many of which are very good indeed, coordinated in practice by the needs and pressures of users. Industry is the major user, but cannot yet speak with one voice. What Industry requires from Information Services varies from industry to industry and from enterprise to enterprise. And how the need is expressed varies according to who is talking. An expression of these needs for large industry was given at Lancaster (3) and for smaller industry at the Luxemburg Workshop (4) . How well, currently do the U.K. services meet these needs? The large companies, particularly the transnationals, will answer very differently from the small and medium-sized enterprises (the 'SME's) on whose growth so much hope is placed for reduction of unemployment.

Yet a uniformly acceptable solution must be sought and could result in one Agency. For such an Agency in U.K., there could be conflict for control between three Government departments - the Department of Industry, the Department of the Environment and the Department of Education and Science, added to which the power of the Post Office with its monopolistic control of communications channels can never be overlooked. Devolution could add further complications in regard to Scottish and Welsh contributions.

Existing Services

The Services we are considering are those already operating and which must form the basis of the resource of a National Agency.

(1) U.K. has good national library services organised under the umbrella of the British Library. The British Library is a corporate body of operating independence, but in fact largely financed by the Department of Education and Science (5). Its organisation is historical and practical, comprising three Divisions - Reference, which includes the Science Reference Library, staff 1118. Lending, staff 692, Bibliographic Service, staff 172, plus a Research and Development Department with 32 staff (6). The retrieval service operated through BLAISE (7) since April 1977 is widely accessible, but shows the usual weakness in non-technical areas.

The needs of industry for technical and scientific information are - with one glaring exception of which more later - well met by services from the British Library plus the independent national services offered by UKCIS (UK Chemical Information Service) and many other similar but smaller services based on professional bodies. Scientists and technologists have not waited for government to organise their information and the initiative of professional societies in moving from publication through abstracting to computer storage and on-line retrieval has met a recognised need.

(2) In addition there are the regional Public Libraries. Some of the big city libraries in U.K. provide an outstanding business information service, not only in respect of data available, but also in the calibre and knowledgeability of senior staff.

However the 'regionality' is both a plus and a minus. The plus lies in a degree of regional specialisation in the information required by the local industries. The minus is financial. These libraries are funded directly by the appropriate region (county, city etc), but in fact the major part of the money comes from the rate support system provided to the local authority by the Department of the Environment; the actual obligation to provide a library service and the monitoring of the quality of the service are the business of the Department of Education and Science (5); now a large city may have major industry located outside its political boundary and therefore not contributing overtly to its upkeep through the rates or local taxes, yet nevertheless by any logical geography in its catchment area. Here is the source of a strain on the city librarian who is asked why he wishes to devote resources to these non-ratepayers. Herein lies a fiscal nonsense which has to be resolved.

(3) Major industry partly serves itself and partly makes sure that it is well served by others. How else would it be major? Industry, even manufacturing industry, does not live by technology alone. It needs concomitant information about money, people, competitors' and government activities - these are the ingredients of opportunity. Most of this is theoretically available, but in a multiplicity of not always easily accessible publications. Nevertheless big industry goes out and gets it and, until recently, has not concerned itself overmuch with improving the public information service.

The Research Associations - peculiarly British institutions serving sectors of industry on a cooperative basis and partly (originally 50%) funded by Government - provide to their members information services which can be of high quality but inevitably this varies with the strength of the R.A.(8). These R.A.s should be particularly valuable to the smaller firms who have not the in-house resources of the big companies. The small firms have probably only just begun to realise what they might be missing and here lies one of the big challenges.

The small firms in U.K. are also cared for by the Department of Industry through its Small Firms Information Service and also through its service for exporters. Here at least is one department that recognises the need, but of course action is confirned to the scope of the department.

Industry's official route for improving the quality of publicly available information would presumably be through the Confederation of British Industry (CBI), but, until recently, the CBI has shown little awareness of this issue. By setting up the ASLIB/CBI Panel it has now made a significant move towards recognition of the importance of the information resource. The pressure towards this has come from information management and not, regrettably, from top management (9). ASLIB particularly is very conscious of this and is working hard to improve the position; at present ASLIB must be considered the leader of this activity in U.K.

(4) On-line retrieval services are now widespread and industry, largely big industry, is a major user. Such services need to be a part of the national plan and not surprisingly various bodies such as CBI, UNICE, ASLIB, EIRMA (the European Industrial Research Management Association) and EUSIDIC (the European Association of Scientific Information Dissemination Centres) have issued statements outlining their needs. Up to now such services have been commercial and therefore assumed to be responsive to customers' needs, but the imminent arrival of EURONET, the European Community network, has brought a new factor. There is available a joint ASLIB/CBI memorandum on this subject, which in fact differs little from what all other bodies representative of industry have said.

The weak area in currently available data bases is that of commercial, economic and demographic information which industry would like to see extended. It is not that the primary information is secret or not published, but that it is to be found in scattered and incompatible formats.

Outline of a Policy

With that background, let us assume that a National Industrial Information Agency comes into existence. It must report to a government department and the Department of Industry seems a logical choice. The action programme would contain at least the following items:

(1) Ease of access

For universal facility of access, the Public Library system must be mobilised. This has important funding implications, but surely not insuperable. On-line searching should be available in the bigger centres for a commercial price. Indeed access to on-line sources should be no more intricate than using a telephone or TV set; here is a message for the Post Office.

(2) Availability of Commercial Information

The large manufacturer, no less than the small, wants to know about his market - the customers and competition. Industry needs easier access to statistical information such as is indeed freely published by governments. The CRONOS (10) data bank and software could be a major contributor.

(3) Standards and Specifications

This is the glaring exception to which reference was previously made. Industry, and exporting industry particularly, is handicapped by the difficulty in ascertaining what national standards, specifications and codes of practice apply in other lands. In U.K. provision of this information is another monopoly, that of the British Standards Institution. The Agency would need to press here.

(4) Industrial Contribution

To improve the availability of information for industry in general in the national interest, industry in particular would need to contribute more. Proprietary industrial information (3) is jealously guarded and correctly so; but this does not mean that its value is beyond price. A proper payment for e.g. environmental research results put into international data banks could reduce the opposition. Without this, it is difficult to see how the worldwide environmental chemicals data base envisaged by United Nations Environmental Program can ever be effective; DESCNET (U.K.) and ECDIN (E.E.C.) are similarly affected.

(5) *Training*

An Industrial Information Agency must join other government agencies in promoting training. The particular need is that of transforming the accepted profile of an Information Officer into that of an Intelligence Officer (3).

(6) Development

The Agency should encourage industry to develop top management who recognise information as an industrial resource of comparable value to the capital and labour resources. This will have value not only within the firm but also in the councils of national bodies such as the CBI with its links to Government and the Community.

(7) User Representation

It is essential that such an Agency have a 'User Group' with teeth. Advisory User Groups whose views are 'noted' and brushed away are useless; there is a need for a body at least as effective as a supervisory board.

Postscript

There is a case for a genuine national programme and this would imply a government agency, for which a skeleton policy has been sketched. Probably the main point in favour is that it would simplify *channels of communication* between industry and the many government departments necessarily concerned. If, however, industry can use its skills to find its way more economically through these channels, the case is weakened. Indeed if the Agency made it more difficult or were inefficient, there would be no case at all.

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TRANSFERRING TECHNOLOGY TO INDUSTRY THROUGH INFORMATION

by

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(Speech for AGARD Conference, October 1978, Paris, France)

Most people think of technology as applied science. But that's a recent development, and not yet universal. The usual course has been for technology to precede science. The breakthroughs of fire or the wheel didn't wait for physicists to explain heat transfer or mechanics. Even in this century, the American inventor, Thomas Edison, wasn't delayed by his failure to understand refractory materials before he invented the incandescent lamp. For thousands of years, and until quite recently, technological innovations came slowly through luck, trial and error, or inspiration.

Many of them still come that way. But the methodology of science is becoming more and more the platform for new technology, and it is speeding up innovations. By the time transistors came, the distinction between basic scientific research and product development was hazy; writers were hard-pressed whether to call the emergence of semiconductors a discovery or an invention.

Thus we are now in an age where the innovation process is being stimulated significantly by the vast resources of available scientific knowledge, and the importance of discrete innovation called "inventions" is rapidly becoming a thing of the past. For instance, who invented television? Or the nuclear reactor? Who invented the computer?

These machines or systems weren't invented. They were "developed"--by many people, over many product generations. They incorporated thousands of individual inventions that themselves often evolved in a random, building-block process.

If you view technological innovation in this evolutionary way--with hundreds of thousands of innovators throughout the world every day taking part in the evolution--then you can begin to appreciate the enormous role played by technology transfer. Viewed in this light, the role of technical information is becoming more important in the transfer of technology. But, the success of information transfer lies in our ability to aggregate and combine incremental bits of knowledge and know-how in ways that materially enhance relevance and application to perceived needs. In short, information must be packaged! You might call the end product "packaged thought." Just as important, appropriate dissemination mechanisms are needed to communicate "packaged thought" in meaningful and productive ways.

Over its sixteen year history, the NASA Technology Utilization Program has experimented with and evolved an array of technology transfer mechanisms and information packaging techniques as part of its effort to encourage alternative uses of aerospace-developed technology. Throughout my discussion I will use the term "secondary uses of NASA technology." This means uses other than the original intent of the R&D, and uses outside the aerospace industry. I would like to focus briefly on the types of mechanisms employed in NASA's Technology Utilization Program, then review in more detail our various packaging techniques, and finally, present the findings of a recent NASA study designed to measure the value of these processes and how they benefit the U.S. industrial community.

The established NASA transfer mechanisms fall into three basic classification types--passive, semi-active, and active. These terms refer to the degree of NASA involvement in the actual application of the technology.

Our extensive announcement and publication activity is considered to be a passive mechanism--passive in the sense that we do not know what specific problems or needs exist in non-NASA user communities. Instead, our publications program concentrates on available technology itself resulting from our aeronautics and space research & development programs rather than on the potential uses of that technology.

Those technological advancements screened and selected for their potential commercial utility are announced in the NASA Tech Briefs journal which is published quarterly and disseminated to over 40,000 U.S. industrial firms. Tech Briefs is a current-awareness medium and a problem-solving tool for its industrial subscribers. Each issue contains information on more than 100 newly-developed products and processes, advances in basic and applied research, innovative concepts, improvements in shop and laboratory techniques, and new sources of technical data and computer programs. Interested firms can follow up by requesting a Technical Support Package, which provides more detailed technical information on the new product or process--including reports, engineering drawings, data compilations, or computer programs. Last year alone, innovations reported in Tech Briefs generated over 125,000 requests for additional technical information--concrete evidence that the publications program is playing an important role in inspiring broad secondary uses of NASA technology.

Our semi-active transfer mechanisms provide technical information packages to meet identified needs or problems specified by industry. These efforts are carried out by a NASA-sponsored network of Industrial Applications Centers, called IAC's, operated by nine universities or non-profit institutes across the nation. Staffed by scientists, engineers and technical information specialists, the IAC's seek to broaden and expedite technology transfer by helping industry find and interpret information relevant and pertinent to a company's projects or problems. While these IAC specialists work with company experts in the problem identification and technology matching process, the IAC often does not know how or in what ways their client is ultimately going to use the information provided. And indeed, many companies prefer a relationship of confidentiality to protect their proprietary interests. It is for this reason that the IAC activity is considered to be semi-active.

Through the IAC's, U.S. industry has computerized access to some 10 million documents, one of the world's largest repositories of technical information. About 2 million of these documents are NASA reports covering every field of aerospace activity. In addition, the data bank includes the continually updated contents of 15,000 scientific and technical journals, plus thousands of published and unpublished reports compiled by industrial researchers and by U.S. Government agencies other than NASA. Each month another 50,000 documents are added to this wealth of technical information.

The centers provide industry with three basic types of service. To an industrial firm contemplating a new research and development program or seeking to solve a problem, the IAC's offer "retrospective searches" where they probe the data bank for relevant literature and provide abstracts or full-text reports on subjects applicable to the company's needs. IAC's also provide "current awareness" services--tailored periodic reports designed to keep a company's executives or engineers abreast of the latest developments in their fields with minimal investment of time. And IAC applications engineers offer highly skilled technical and interpretive assistance in applying the information retrieved from the data bank to a company's best advantage. The IAC's charge nominal fees for their various services based on a "value-added" pricing policy.

One interesting feature of this type of face-to-face interaction between the industrialist and technologist is that in many cases, the technologist helps the industrialist define his problem. Our experience indicates to us that the problems presented to the technologists do not, for various reasons, reflect the true technical problem. As the two interact with each other, the technologist gains a deeper insight to the problem and can help the industrialist arrive at the real, rather than perceived, problem.

A related service to industry is provided by NASA's Computer Software Management and Information Center (COSMIC) at the University of Georgia. COSMIC collects, screens and stores computer programs developed by NASA and other government agencies. Adaptable to secondary use by industry, government or other organizations, these programs perform such tasks as structural analysis, electronic circuit design, chemical analysis, design of fluid systems, determination of building energy requirements and a variety of other functions. COSMIC maintains a library of some 1600 computer programs, which are available to users at a fraction of their original cost.

The passive and semi-active information dissemination programs I have just discussed are aimed primarily at the U.S. private sector; however, in the public sector we have a different situation. Here our efforts are directed toward demonstrating that aerospace technology can be useful in solving recognized public-oriented problems in areas such as health, transportation, public safety, environment, and so on. Since the primary beneficiaries of these projects are basically the U.S. public and not private industry, we work on a cooperative basis with other government agencies at the federal, state and local levels. This hands-on engineering approach to technology transfer is, by definition, an extremely active mechanism, because we assume the final responsibility for the actual application. In this type of transfer, the item transferred is a product, as opposed to information.

My purpose here today, however, is to focus on the importance of technical information systems in the transfer process. Therefore, I will not discuss or elaborate on this latter mechanism further.

Normally when we discuss the transfer of aerospace technology, we talk about gas turbines or cardiac pacemakers or heat pipes or other products. It is easier to quantify product transfers, to take credit for them, to trace their history, and to analyze what steps were effective in bringing them about. While that type of product transfer is important, the elusive, intangible, but ubiquitous "information transfer" is even more important.

We believe that considerable insight and a fundamental understanding of the information transfer process can be gained by evaluating the results-- or benefits--of the process. In its recent cost-benefit study of the Technology Utilization Program, conducted by the Denver Research Institute (DRI), NASA analyzed quantified benefits realized by users of TU information products provided through NASA publications, Industrial Applications Centers and COSMIC. These benefits data were obtained empirically from over 700 in-depth interviews with users of these NASA transfer programs selected on a random sample basis. The resultant benefits and user investment data obtained in this manner were then statistically analyzed and exprapolated to the total population of user transactions which occurred from 1971 through 1976.

Interviews with users of NASA technology were conducted by ten different individuals in five separate participating institutions using identical interviewing procedures. On the strength of the large random sample data set, this study represents by far the largest and most detailed cost-benefit analysis of the technology transfer process conducted to date. Prior studies of technology transfer have generally used non-random sample sizes of less than 100. Although the sample size of 700 user transactions selected for this study is small compared to the population size, it was calculated from a standard population proportion formula to achieve 90 percent confidence levels.

Before I discuss the specific results of this study, however, it is important to point out one of the basic conclusions arrived at concerning the information transfer process. That is that <u>information transfer is a rational economic investment activity</u>. In other words, users operate in a speculative investment mode with some degree of uncertainty, risking tangible resources--time, money, equipment, and the like-- in the assimilation, adaptation and use of the information before the value or utility of the information to his needs are actually known. In this sense, therefore, technical information cannot be compared with a tangible consumer product. When buying a consumer product the user perceives beforehand a definite level of utility of that product and thus can affix an appropriate value or price that he is willing to pay for that product. In the case of information, however, the user has difficulty perceiving such utility before the fact, and therefore must assume a level of risk in its use. This assumption of risk, or investment activity, is very similar to investments in the stock market, oil exploration or even racetrack betting--where risk and uncertainty are high.

Now, with this as background, let us look more closely at the DRI study methods and results. I am sure you will find them to be most illuminating and reveal a new and interesting perspective on the value of information transfer processes.

The principal objective of the NASA cost-benefit study was to quantitatively assess the effectiveness of each of the information product packages made available to industry through its information transfer mechanisms--publications, IAC's and COSMIC which I previously described. This quantitative analysis (Figure 1) required that we investigate (1) the cost to NASA to make various types of information products available, (2) the cost to the user, or rather his investment, to put these information products to use, and (3) the economic benefits realized, or realistically expected, from the use of specific information products in new or improved products, processes or services. By so doing, we could then compare the relative cost-effectiveness of our various information packaging techniques while at the same time be able to measure the overall benefit-to-cost ratio of the program.

<u>TECHNOLOGY TRANSFER</u>
<u>COST-BENEFIT DATA</u>

- NASA PRODUCTION COST (C_n)
- USER COST/INVESTMENT (C_u)
- GROSS USER BENEFIT (B)

<u>COST-BENEFIT RATIO (R)</u>

$$R = \frac{B - C_u}{C_n}$$

FIGURE 1

The basic unit of analysis for each of the information products investigated was an individual transaction--that is, where an individual or industrial firm requested and received a technical information product from NASA--a report, shop drawings, a computerized retrospective search, and so forth. Since a total of nearly 340,000 such transactions occurred between 1971 and 1976, we elected to randomly sample the population of transactions for each of the information products concerned. Figure 2 shows the number of transactions by product and the average unit production cost to NASA for each transaction.

PRODUCTION COSTS & TRANSACTIONS BY INFORMATION PRODUCT (1971-76)

INFORMATION PRODUCT	NUMBER OF TRANSACTIONS	UNIT COST PER TRANSACTION
PUBLICATIONS:		
• ANNOUNCEMENT FLYER	107,750	$ 2
• TU COMPILATION ITEM	134,100	30
• TECH BRIEF (SINGLE)	56,900	75
• TECH BRIEF JOURNAL	12,250	65
RETROSPECTIVE SEARCHES (RSS):		
• RSS-1: UNEDITED	7,000	100
• RSS-2: INTERACTIVE	850	130
• RSS-3: EDITED	7,700	550

FIGURE 2

The unit production costs shown here indicate the relative degree of effort put forth by NASA to produce each type of information package to meet the users' needs. These average costs range from $2.00 per unit transaction based on a brief announcement flyer, such as I have here, to a full-blown retrospective search of the NASA data bank, which is tailored to meet a specific problem identified by an IAC client. Thus this list represents a broad array of TU information products, each having its own level of added value.

USER ESTIMATES REQUESTED

- ESTIMATED BENEFITS AND COSTS REALIZED OR EXPECTED OVER TIME
- TYPE OF APPLICATION ACTUALLY REALIZED OR PLANNED BUT NOT YET REALIZED
- ESTIMATED "CHANCE-OF-SUCCESS" FOR PLANNED USES OF INFORMATION PRODUCT

FIGURE 3

Three areas of inquiry were pursued in each of the interviews conducted (Figure 3). First, the user was asked to estimate costs and benefits, distributed over time, that he attributed directly to receiving the specific NASA information product. Second, he was asked to characterize the type of application he achieved, or reasonably expected to achieve in the future from the technical information received. And finally, he was asked to estimate his "chance-of-success" for applying the information to projects planned, but not yet realized. In terms of anticipated applications, only the amount of estimated benefit times his estimated probability of success was recorded. For example, the user may have estimated a before tax profit increase of $50,000 during the coming year, but his "chance-of-success" for achieving this increase was only 10%. In the statistical aggregate, this case would have an expected net benefit of only $5,000. ($50,000 x 0.10).

APPLICATION MODES

MODE		TYPE OF APPLICATION
0	-	NO APPLICATION/NOT RELEVANT
1	-	INFORMATION USE ONLY
2	-	IMPROVED PRODUCTS OR PROCESSES
3	-	NEW PRODUCTS OR PROCESSES

FIGURE 4

The types of use of technical information were then classified in one of four application modes. Figure 4 indicates the four modes of information use--Mode 0 denoted cases where

the information package was not relevant to the user's needs; therefore no use or application was realized. Mode 1 indicated those cases where only the user's knowledge was advanced by virtue of the information received, but in which no tangible application of the information resulted. Mode 2 reflected application of the information in improving the user's existing products or processes, and Mode 3 applications were for new products or processes.

Probability distributions over these application modes varied considerably for the different types of information product packages investigated. In general, the probabilities for achieving tangible use of information in new or improved products or processes-or Mode 2 and 3 applications--increased as a direct function of information product "added value." This, of course, was to be expected. For example, edited retrospective searches tailored and packaged by experts to meet the requirements of specified problems had a much higher probability of achieving Modes 2 and 3 than did results of unedited searches.

TRANSACTION DATA AND PROBABILITIES

INFORMATION PRODUCT	PROBABILITY FOR MODES 2 & 3	UNIT COST PER TRANSACTION	USER COST	EXPECTED NET BENEFIT PER TRANSACTION
PUBLICATIONS:				
• ANNOUNCEMENT FLYER	.034	$ 2	$180	$ 110
• TU COMPILATION ITEM	.093	30	260	640
• TECH BRIEF (SINGLE)	.090	75	270	600
• TECH BRIEF JOURNAL	.118	65	330	910
RETROSPECTIVE SEARCHES (RSS):				
• RSS-1: UNEDITED	.087	100	250	1,300
• RSS-2: INTERACTIVE	.163	130	320	1,740
• RSS-3: EDITED	.313	550	870	4,900

FIGURE 5

Figure 5 shows the range of statistical probabilities for achieving Mode 2 and 3 applications for each of the information product types investigated. These data, shown in column 1, were derived analytically from modal distributions of applications specified by information users interviewed in the random sample. Note that there is a slight overlap between publication products and retrospective searches conducted by NASA Industrial Applications Centers. This, we believe, is largely due to the direct involvement of information and technical specialists in the packaging and interpretation of technical information products to meet specific user problems or needs--a process which is characteristic of the interactive and edited retrospective searches RSS-2 and RSS-3, respectively.

Columns 3 and 4 represent the statistical aggregate values for user costs and expected net benefits, for each of the information products listed. These data, obtained directly from information users in the more than 700 interviews, show that the more the user invests in applying the information the higher his expected net benefit can be. Although the involvement of specialists in the packaging process is more costly on the average, as shown in column 2, the probability for generating tangible use of the information product (column 1) and the expected net benefit to the user (column 4) increases substantially.

A major question for any technical information product or service concerns how much potential value to the user is added by the unit production costs to provide that product or service. Another closely related question concerns how much the user invests in comparison to the benefits he actually obtains.

Figure 6 shows a very strong correlation between the expected net benefit per product transaction and the NASA unit cost to provide each product transaction. A similar high correlation exists between expected net benefit and the user's investment per transaction. The data points in the graph represent the aggregate, or expected, net benefits and costs for each product type rather than individual user estimates which typically have considerable variation. It should be remembered that the data were collected by ten different individuals at five different participating institutions.

The striking correlations between the values shown in this graph indicate clearly that value is being added to NASA technical information through the various TU packaging processes, and that the information transfer process is indeed a rational economic investment activity. Qualitative relationships between user benefits and costs of adding value to technical information have generally been widely believed by information scientists. We feel that these relationships have now been statistically quantified as a result of this study, apparently for the first time.

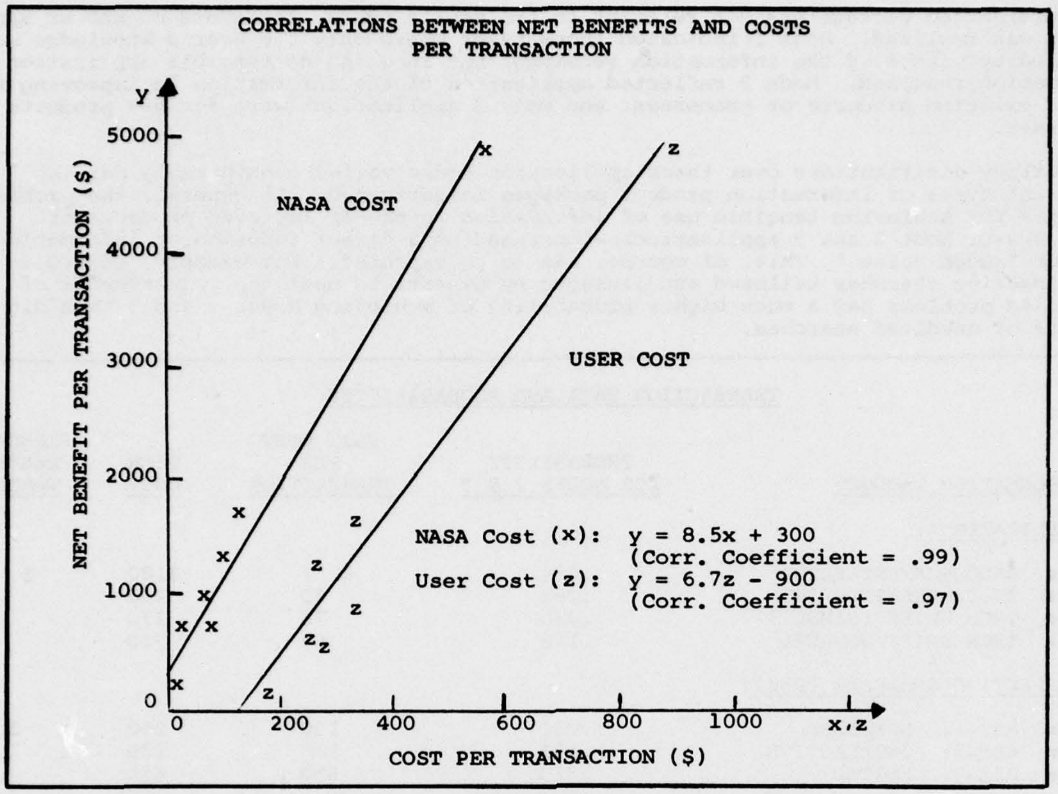

FIGURE 6

It is significant to note the important role played by the variety of information dissemination mechanisms available through the NASA Technology Utilization Program. The broad and diverse array of information products--flyers, technical announcements, and computerized information searches--each with its own level of added value, provide users with a range of information product alternatives and investment levels from which to choose. In this context, the location of both correlation lines in this graph when the costs are near zero is also of interest. The production cost line (x) indicates that some net benefits (about $300) might still be realized by users of NASA technical information if the TU Program did not exist. However, the expected net benefit would be very small and probably not worth the investment to many users. This is supported by the user cost line (z) which indicates that approximately $200 (or about one engineering man day) of user investment would be required to generate this expected net benefit of $300. To some the rate of return on this investment would be substantial; however, the risks due to the uncertain utility of aerospace technology to non-aerospace users would be enormous. The NASA TU Program, however, reduces that uncertainty by screening, evaluating and packaging the aerospace technology, thereby increasing its economic value to potential users.

So as we already knew or suspected, the value of technical information products and the transfer mechanisms designed to bring about useful and tangible applications can have a significant and beneficial economic impact. The process, however, requires that users actively participate and invest their time and resources if they expect to materially gain from the wealth of technical information resources currently available.

As a result of this study we now have a better understanding of the transfer process, how it works, and the levels of effectiveness with which each element operates. The next logical step, it seems to me, is to determine whether similarities exist in technologies that generate economic benefits. From this point, it may be possible to influence the general direction of R&D to yield those technologies which our studies indicate create the greatest economic return. Of course, this concept does not apply to basic research.

This brings me back to my opening comment that science is influencing the progress of innovation. Therefore, if the transfer of technology to the industrial marketplace and the resultant economic growth of the community is a major consideration of R&D planners, then one way to achieve this objective would be to "guide" R&D toward high yield technologies. Beyond this point, the key connector between the technology and the user is the packaging of information which I described earlier.

In summary, the total process of technology transfer is not complete unless it embraces an active role in guiding R&D, extracting its results, and packaging and disseminating the knowledge for specific uses in the industrial marketplace.

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This document contains the papers delivered to an AGARD Technical Information Panel Specialists' Meeting on "Information and Industry" held in October 1978 in Paris. In particular, several of the papers address representative national programmes on this subject from Canada, Denmark, France, United Kingdom and the United States. The theme of the meeting stressed the increasing importance being given to the exploitation of scientific and technical information developed as a result of defence and aerospace research. Papers were presented under the following three Session headings: Industrial Information Requirements, Mechanisms for Information Transfer and Management Considerations in Information Transfer. The papers represent a review of the state-of-the-art for 1978 with the object of communicating to government and industry the kinds of information services which exist and can play an important part in technology transfer and the means of accessing this information.

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